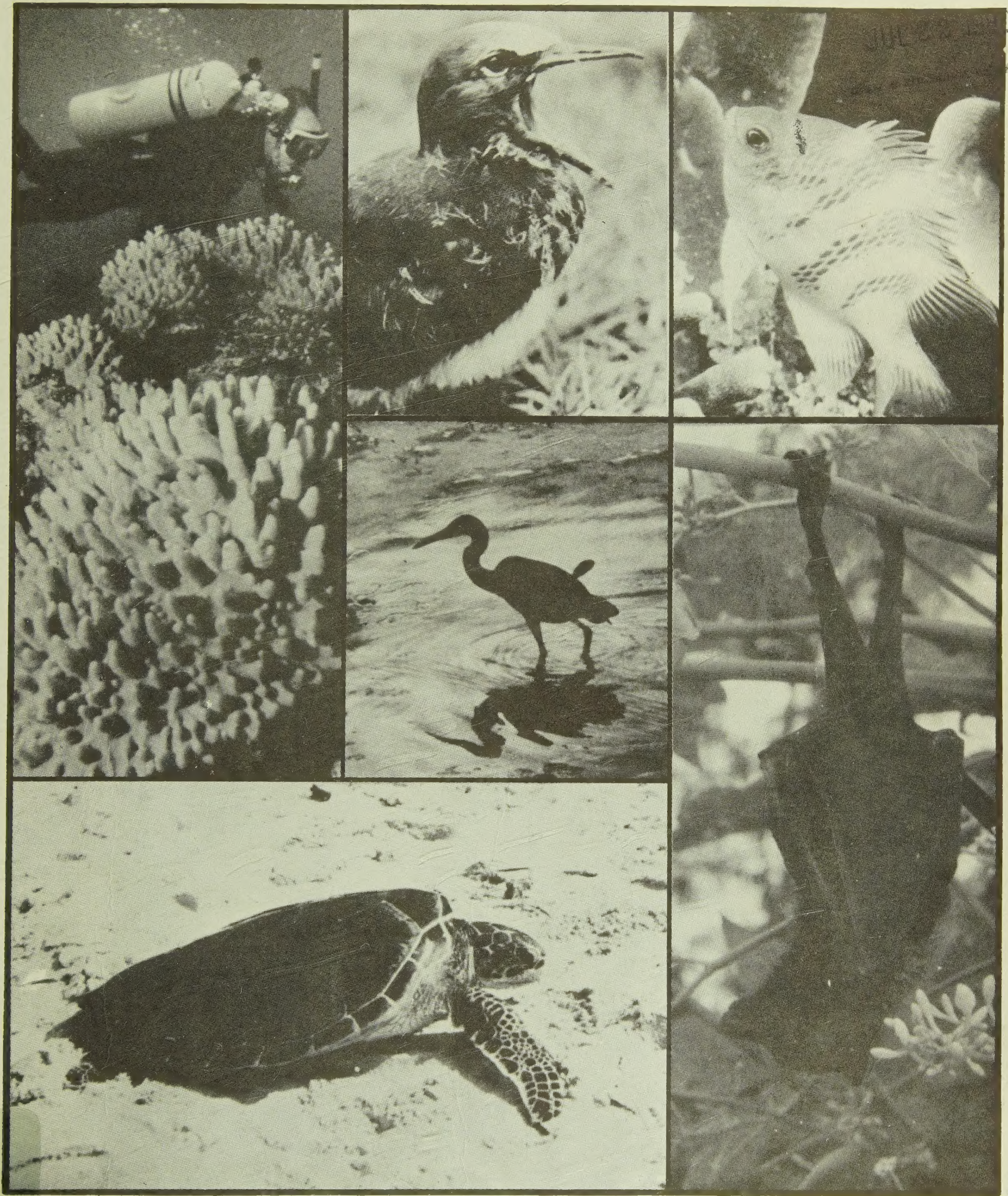
Fy 1979

AQUATIC AND WILDLIFE RESOURCES



Guam **DEPARTMENT OF AGRICULTURE**

JULY 1978 – JUNE 1979

FY 1979

ANNUAL REPORT
Fiscal Year 1979

GUAM
AQUATIC & WILDLIFE RESOURCES DIVISION
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DEPARTMENT OF AGRICULTURE
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July 1, 1978 to September 30, 1979

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Table of Contents

Section I. Guam Fisheries Investigations - Project FW-2R-16 (Federal Aid in Fish Restoration Act)

Page

Job F-1 Creel Census and Fish Population Studies 2
  Job F-1A Data Processing 2
  Job F-1B Offshore Fishing 9
  Job F-1C Inshore Fishing 19
  Job F-1D Fish Weirs 49
  Job F-1E Aerial Fishery Surveys 51
  Job F-1F Reef Fish Population Study 58
  Job F-1G Compilation of a Checklist of the Food and Game Fishes of Guam 64
Job F-4 Habitat Improvement of Inshore Lagoons 65
Job F-7 Limnological Survey of the Major Streams and Rivers in Guam 97
Job F-8 Experiments with Moored Offshore Fish Attracting and Congregating Devices 115

Section II. Guam Fisheries Investigations (Miscellaneous Funds)

Project Title: National Marine Recreational Fishery Survey 133
Project Title: Third Annual Marianas Fishing Derby 143
Project Title: Feasibility Study to Establish an Ika-Shibi Fishery on Guam 154
Project Title: Survey of Edible Marine Shellfish and Sea Urchins on the Reefs of Guam (Abstract) 166

Section III. Guam Fisheries Development - Project F-D-1 (Federal Aid in Fish Restoration Act)

Project Title: Masso Reservoir Development 168

Section IV. Aquaculture (Public Law 88-309 Matching Funds)

Project Title: Development of Polyculture Fishing Farming Under Tropical Conditions 202

Section V. Guam Wildlife Investigations - Project FW-2R-16 (Federal Aid in Wildlife Restoration Act)

Job W-2 Study of the Guam Deer 218
Job W-4 Study of the Fruit Bat 230
Job W-6 Study of the Guam Pig 261
Job W-10 Habitat Improvement for Wildlife 268

Job W-11 Preparation for a Development Project to Establish Game Management Areas 270
Job W-12 Manuscript Revision of Previous Guam Wildlife Jobs 272
Job W-13 Study of the Birds of Guam 274

Section VI. Guam Wildlife Investigations (Miscellaneous Funds)

Project Title: The Current Status and Distribution of the Marianas Fruit Bat on Guam (Abstract) 332

Section VII. Technical Guidance - Project FW-2R-16
(Federal Aid in Fish and Wildlife Restoration)

Job TG-1 Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources 334

Section VIII. Law Enforcement (Local Funds)

Law Enforcement Section Annual Report 339

Section I

Guam Fisheries Investigations
Project FW-2R-16
(Federal Aid in Fish Restoration Act)

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam
PROJECT TITLE: Guam Fish and Wildlife Investigations

PROJECT NO.: FW-2R-16
STUDY TITLE: Creel Census and Fish Population Studies

Period Covered: July 1, 1978 to September 30, 1979.

This study consists of several separate and distinct jobs, each of which will be treated below in its own section. The jobs are: data processing; offshore creel census; inshore creel census; checklist of fishes; and reef fish transects. There are also sections covering fish weirs and our aerial surveys of fishermen and marine life.

The real significance of the various creel censuses and fish population studies in this project will become apparent when proper fishery management plans are prepared for the various fisheries at the local and national levels in accordance with the Fishery Conservation and Management Act of 1976. The fishery management plans are intended to protect local and national interests, both commercial and recreational, and will do so only if they are based on sound data and reflect equally sound ecological and management principles. The Government of Guam is already reviewing all the laws pertaining to its living marine resources and calling upon AWR to supply information regarding standing stocks and harvest rates, and to recommend where regulation is needed and to what degree.

INVESTIGATIONS:

F-1A
Data Processing

A major effort was made this year to computerize data storage and data analysis for the creel censuses. Data is stored in three different types of records for each creel census interview. The first record includes information on the date, place, time, method, number of fishermen, total catch, and weather conditions (Figure 1.). This data provides the basis for estimating participation and catch per unit effort. The second and third records detail the catch. The second lists by species all fish which have been individually weighed or measured for length, or both, and provides the basis for all length-weight regressions, length frequency analysis, etc. The third record accounts for all fish by species that have not been individually measured. Together, the second and third records allow for a breakdown by species of what is caught, and where, when and how. The species codes used are from the 10-digit coding system designed for the NMFS National Marine Recreational Fishery Survey.

The offshore creel census data from July 78 through September 79 was entirely coded and is stored on diskettes. To date no inshore data has been coded or stored. In the future, all data should be coded within one week of the census so that monthly and quarterly reports may be issued on a timely basis.

Computer programs to handle the offshore data and generate monthly, quarterly and annual reports of the recorded and estimated catch, participation and catch per unit effort (CPUE) were prepared for AWR by the Government of Guam Bureau of Planning. Tables 1-4 in the Offshore Creel Census section are summaries of these computer reports. Examples of the actual computer reports are presented in Figures 2-4 of this section. Additional programs are being prepared to generate the coefficients a and b for each fish species in the length-weight formula $wt = a\,ln^b$ or $\log wt = \log a + b \log ln$; and to generate all the same reports for the inshore creel census data as for the offshore data. Handling the inshore data is slightly more complex because the fishermen are usually interviewed while fishing, and not after they have stopped for the day as in offshore interviews.

As the computer programs are developed and refined, it should be possible to include data from previous years (prior to 1978) in the analysis. This is important because, as also noted in the offshore creel census section, seasonal trends for a number of years must be examined before any real understanding of the mechanisms involved can be achieved. Over a period of years it may be possible to correlate tuna and mahimahi migrations with certain climate factors so that realistic predictions of future migrations may be made. Such information will benefit both the fishermen and fish dealers by allowing them to schedule boat overhauls and predict supply schedules to minimize losses.

Report prepared by Henry G. Tucker

FIGURE 1. DATA TRANSCRIPTION CODES

COLUMN	CODE	TRANSLATION
1	1	Data Card 1: trip information
2- 4	000-999	Boat Registration Number or Consecutive Interview Number
5- 6	01-99	Last 2 digits of year (1978 = 78, 1979 = 79, etc.)
7- 9	001-366	Julian Date
10-11	01-12	Month (January = 01, February = 02, etc.)
12-13	01-31	Day of Month (January 25 = 25, etc.)
14	1-3	Day of Week (weedkay = 1, weekend = 2 weekday holiday = 3)
15-16	10-18 51-56	Inshore Location (see attached sheet) Offshore Location (" " ")
17-18	00-99	Location: inshore survey codes 01-65 indicate shore area; offshore survey codes 00-99 indicate ocean area (see attached sheet)
19	0-9	Fishing Method (see attached sheet)
20	0-9	Interviewer (see attached sheet)
21-24	0000-2359	Time of Interview
25-28	0000-2359	Time started fishing or boat departure time
29-32	0000-2359	Time stopped fishing or boat return time
33-35	000-959	Lost Time: hours and minutes not actually fsihing between start time and stop time
36-39	0001-2324	Time Most Fish Caught (from 10am to 1pm = 1013)
40	0-9	Number of Fishermen
41	0-9	Number of Gear Units used
42-43	00-99	Bait, one type per column (see attached sheet)
44-46	000-999	Total Number of Fish Caught
47-50	.000-999.	Total Weight of Fish in Kilograms
51-52	00-99	Total Number of Fish Species Caught

FORM 1 (Cont'd)

COLUMN	CODE	TRANSLATION
53	0-9	Wind Speed, Beaufort Scale
54	0-9	Wind Direction (see attached sheet)
55	0-9	Sea State or Wave Height, Beaufort Scale
56	0-9	Wave Direction, as in column 54
57	0-9	Cloud Cover (0-10% = 0, 10-20% = 2, 20-30% = 3, etc.)
58	0-9	Weather: 1 = fair, 2 = threatening, 3 = rain, 4 = squalls, 5 = thunderstorms, 6 = stormy, 7 = tropical depression
59	1-9	Percent of actual fishing time spent on method in column 19
60	0-9	

Figure 2. Sample computer printout of CREEL 1: catch per unit effort.

```
   DEPARTMENT OF AGRICULTURE - DIVISION OF FISH AND WILDLIFE           79/11/26

        CATCH PER UNIT EFFORT FOR MONTH OF SEPTEMBER 1978
-------------------------------------------------------------------------------------
TROLLING
---------------

      DAY OF              NUMBER OF    NUMBER OF    NUMBER OF    NUMBER OF      TOTAL
      WEEK       DATE     BOAT TRIPS   BOAT HOURS   FISHERMEN    LINES       CATCH(KG)
      ------     ----     ----------   ----------   ---------    ---------   ---------

      SUNDAY      10         13.20        99.91        37.00        46.00      242.500

      WEDNESDAY   13          8.60        51.90        28.00        34.00      176.500

      MONDAY      18          3.00        10.07         8.00        11.00       47.700

      SATURDAY    23         17.50       114.58        50.00        61.00      490.500
      -------    ----     ----------   ----------   ---------    ---------   ---------

      TOTAL       04         42.30       276.46       123.00       152.00      957.200
      ------     ----     ----------   ----------   ---------    ---------   ---------


      CATCH PER BOAT TRIP:          0022.62 KG/TRIP

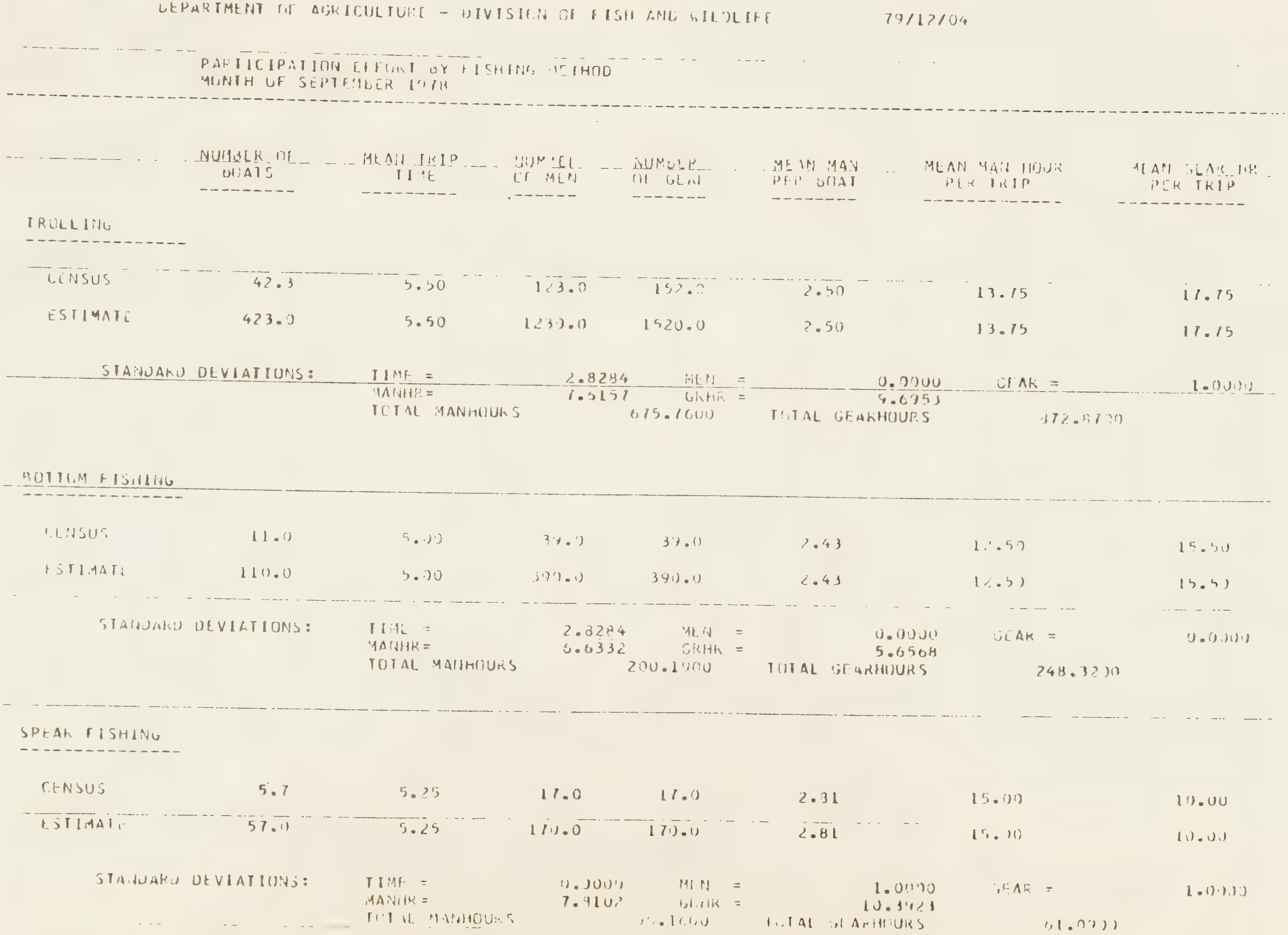
      CATCH PER BOAT-DAY(8HRS):     0027.69 KG/DAY

      CATCH PER MAN-DAY(8HRS):      0011.33 KG/DAY

      CATCH PER LINE_HOUR:          0001.09 KG/HOUR

      TOTAL MANHOURS        675.76      TOTAL GEARHOURS        873.13
```

Figure 3. Sample computer printout of CREEL 2: census and estimate participation by fishing method.



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          DEPARTMENT OF AGRICULTURE - DIVISION OF FISH AND WILDLIFE          79/12/04

               PARTICIPATION EFFORT BY FISHING METHOD
               MONTH OF SEPTEMBER 1978
-----------------------------------------------------------------------------------------------------

               NUMBER OF    MEAN TRIP   NUMBER   NUMBER    MEAN MAN    MEAN MAN HOUR   MEAN GEAR HR
                 BOATS        TIME      OF MEN   OF GEAR   PER BOAT      PER TRIP        PER TRIP
               ---------    ---------   ------   -------   --------    -------------   ------------
  TROLLING
  ---------------

   CENSUS         42.3         5.50     123.0     152.0      2.50          13.75           17.75

   ESTIMATE      423.0         5.50    1230.0    1520.0      2.50          13.75           17.75

       STANDARD DEVIATIONS:   TIME  =          2.8284    MEN   =          0.0000   GEAR =          1.0000
                              MANHR=           7.5157    GRHR  =          9.6953
                              TOTAL MANHOURS        675.7600   TOTAL GEARHOURS       872.8700


  BOTTOM FISHING
  ---------------

   CENSUS         11.0         5.00      39.0      39.0      2.43          12.50           15.50

   ESTIMATE      110.0         5.00     390.0     390.0      2.43          12.50           15.50

       STANDARD DEVIATIONS:   TIME  =          2.8284    MEN   =          0.0000   GEAR =          0.0000
                              MANHR=           6.6332    GRHR  =          5.6568
                              TOTAL MANHOURS        200.1900   TOTAL GEARHOURS       248.3200


  SPEAR FISHING
  ---------------

   CENSUS          5.7         5.25      17.0      17.0      2.31          15.00           10.00

   ESTIMATE       57.0         5.25     170.0     170.0      2.81          15.00           10.00

       STANDARD DEVIATIONS:   TIME  =          0.0000    MEN   =          1.0000   GEAR =          1.0000
                              MANHR=           7.9102    GRHR  =         10.3921
                              TOTAL MANHOURS   [illegible].1600   TOTAL GEARHOURS        61.0000
```

Figure 4. Sample computer printout of CREEL 3: censused and estimated monthly catch itemized by species. Only estimated catch record is shown.

```
    DEPARTMENT OF AGRICULTURE - DIVISION OF FISH & WILDLIFE                                79/11/05

  ESTIMATED       LANDINGS FROM 05 DAYS   TROLLING        FOR JUNE        1979 AT AGANA BOAT BASIN
 ------------------------------------------------------------------------------------------------------

 SPECIES
 ID CODE                 SPECIES NAME                                                   PERCENT                            PERCENT      MEAN      STANDARD
 ----------  --------------------------                                         NUMBER  OF TOTAL     KILOGRAMS    OF TOTAL    WEIGHT   DEVIATION
                                                                                ------  --------     ---------    --------    ------   ---------
 8835281301  ELAGATIS BIPINNULATUS         -RAINBOW RUNNER                        41      5.95        65.620        2.21       1.600      0.300
 8835290101  CORYPHAENA HIPPURUS           -MAHIMAHI                              67      9.73       423.900       14.29       6.320      1.880
 8837010104  SPHYRAENA BARRACUDA           -BARRACUDA                             15      2.18        47.620        1.60       3.170      2.290
 8850030101  KATSUWONUS PELAMIS            -TUNA, SKIPJACK; AKU                  480     69.76       967.500       32.63       2.010      0.850
 8850030403  THUNNUS ALBACARES             -TUNA, YELLOWFIN; AHI                  30      4.36       493.500       16.64      16.450     13.240
 8850030601  ACANTHOCYBIUM SOLANDRI        -WAHOO; ONO                            48      6.97       692.620       23.36      14.420      6.050
 8850035250  GYMNOSARDA NUDA               -TUNA, DOGTOOTH                         3      0.43        16.870        0.56       5.620      0.000
 8850060201  MAKAIRA NIGRICANS             -MARLIN, BLUE                           3      0.43       257.250        8.67      85.750      0.000
 ----------  --------------------------                                         ------  --------     ---------    --------    ------   ---------
 0000000000  TOTAL                                                               688    100.00      2964.900      100.00       4.300      7.180
```

F-1B Offshore Fishing

Creel censuses have been scheduled at the Agana Boat Basin at the rate of four censuses each month (twice on weekdays and twice on weekends or holidays) since February 1978. In addition, creel censuses have been scheduled at the Merizo Pier twice monthly (one weekday and one weekend) since January 1979. All creel census days are chosen by lottery at least one month in advance. At the Agana Boat Basin, weekday censuses are conducted continuously from 1400 to 2100 hours, and weekend censuses from 0600 to 2100. A study conducted between March and June 1978 indicated that about 90% of the boats fishing on any particular day will be included in a census covering those hours. At the Merizo Pier, censuses are conducted continuously from 1500 to 2100 on weekdays, and from about 1300 to 2100 on weekends. All fishing parties either leaving or returning during a census are interviewed, and their catches are recorded on a standard census form as shown in Figure 1.

There are three major fishing methods employed by offshore fishermen on Guam. The most widely practiced of these is multiple-line surface trolling from small recreational type boats, usually less than 30 feet in length. The other two methods are deep-bottom fishing (usually at depths from 100 to 200 fathoms), and nearshore spearfishing from boats at locations which are generally inaccessible to people restricted to using other means of transportation.

The estimated monthly and annual catch and effort values for each of the methods are presented in Tables 1, 2 and 3. The monthly catch and effort estimates in Tables 1 and 2 are derived from the formula:

$$(B_w/b_w)\ (W/w)\ (C_w) + (B_h/b_h)\ (H/h)\ (C_h) = C_E;$$

where B_w and B_h are the number of boats fishing during the weekday and holiday census, b_w and b_h are the number of boats which completed the census form upon the month, w and h are the number of weekday and holiday creel censuses conducted, and C_w, C_h and C_E are the weekday censused catch, holiday censused catch, and total monthly estimated catch respectively. For Table 3 the same basic formula was applied to derive quarterly estimates.

Trolling

Table 1 presents a monthly breakdown of effort and catch estimates for the trolling fishing method. An estimated 10,114 fishermen spent 65,185 man-hours using on the average 1.3 lines apiece during this 15 month report period.

Generally the trolling catch consisted of at least 14 species belonging to the families Scombridae (tuna), Coryphaenidae (dorado), Istiophoridae (billfish), Sphyraenidae (barracuda), Carangidae (jack), Carcharhinidae (requiem shark), and Belonidae (needlefish). At least one swordfish (Xiphias gladius, family Xiphiidae) was caught trolling after dusk at 11-mile reef, although none were ever recorded in a creel census. The monthly censused and estimated catches of the seven major trolling species are presented in

Table 4; these species accounted for more than 98 percent or 67 metric tons of trolling fish landed between July 1978 and September 1979.

In our annual report last year (FY 78), we reported an estimated trolling harvest of 84.9 metric tons landed at the Agana Boat Basin from July 1977 to June 1978. In contrast, this year the catch for the same period was only 55.5 mt. Most of the deficit is attributable to smaller catches of skipjack tuna, down nearly 14 mt from 30 last year to 16 this year, and wahoo, down about 9 mt from 14 to 5. Catches of mahimahi and yellowfin tuna were approximately the same both years at about 14 mt each. This year the big increase was in the estimated landings of blue marlin, up from 1.4 to 3.9 mt.

Most of the fish species caught trolling offshore are seasonal in that they are primarily caught during certain times of the year when their annual migrations bring them past Guam. The abundance of seasonal fish is fairly accurately indicated by the amount caught. For the seven major trolling species, the estimated monthly landings at the Agana Boat Basin are shown in Table 4, and graphed in Figure 2 for the period from July 1977 through September 1979. It is important to point out that while fish migrations follow roughly the same pattern each year, there can be considerable variability in the number of fish, average size of the fish, and the timing of the migration.

Bottom Fishing

Table 2 presents a monthly breakdown of effort and catch estimates for the bottom fishing method. An estimated 1,160 fishermen spent 5,004 man-hours bottom fishing during this 15 month report period. This resulted in an estimated twelve month catch of 4.4 metric tons of bottom fish down from 13.2 metric tons last year.

As last year, the most abundant species caught were lehi (*Aphraeus rutilans*) "salmon" (*Aprion virescens*), onaga (*Etelis carbunculus*), ehu (*Etelis marshi*), kalikali (*Pristipomoides auricilla*) and gindai (*Rooseveltia brighami*), all of which belong to the family Lutjanidae (snappers). Other snappers and representatives of the jack family Carangidae, contributed lesser amounts to the total harvest. A more detailed breakdown showing the percentage of each species in the total catch will be presented next year when our computer program will be refined.

Spearfishing

During this census period, an estimated 545 fishermen spent 4,614 man-hours harvesting approximately 1.3 metric tons of fin fish and other marine animals. The major species of fish included in the catch belong to the families Acanthuridae (surgeon fishes), Carangidae (jacks), Holocentridae (squirrel fishes), Kyphosidae (rudder fishes), Labridae (wrasses), Serranidae (groupers), and Scaridae (parrot fishes). The top shell (*Trochus niloticus*), lobster, octopus and a few *Tridacna* clams contributed a small amount to the total spearfishing harvest.

Only quarterly estimates of effort and catch are presented in Table 3, because our data on this method are too sporadic to make complete monthly estimates possible. In addition, much spearfishing is done on the other side of the island during the summer months or at night, making reliable data difficult to obtain. There appears to be a definite off-season, from October through March with the majority of the offshore spearfishing being done from July through October. The Table also shows the relative percentages of effort and catch estimated for each quarter. Spearfishing effort for the July - September 1979 quarter was considerably lower than the corresponding months in 1978 due to a series of tropical depressions and typhoons which passed just south of Guam making this a particularly good year for surfers but not for spear and bottom fishermen.

General

Participation, effort, CPUE and total catch for all three offshore methods are compared in Table 5. Trolling is seen to be the most popular method with 86 percent of the participating fishermen and 87 percent of the total man-hours expended. Trolling is also responsible for 91 percent of the estimated offshore harvest.

Report prepared by Staff

Table 1. Monthly and annual effort, catch and CPUE estimates for trolling derived from data collected at the Agana Boat Basin between July 1978 and September 1979.

MONTH	NO. CENSUS DAYS	NO. BOAT-TRIPS CENSUSED	BOAT-HOURS	ESTIMATED MONTHLY NO. BOATS	NO. MEN	ACTUAL CENSUSED MAN-HOURS	ESTIMATED MONTHLY NO. MEN	NO. LINES	CATCH/ BOAT (KG)	CATCH/ MAN-HOUR (KG)	CATCH/ LINE-HOUR (KG)	ACTUAL CENSUSED CATCH (KG)	ESTIMATED MONTHLY CATCH (KG)
1978													
July	4	29.7	183.7	203.5	97	559.5	655.5	117	17.07	0.91	0.81	507.0	3870.8
August	4	51.2	327.6	344.3	149	908.3	1008.5	191	23.78	1.34	1.21	1217.6	9785.5
September	4	42.3	276.5	423.0	123	675.8	1230.0	152	22.62	1.42	1.09	957.2	5907.0
October	4	27.5	157.3	191.7	78	408.3	528.0	107	19.31	1.31	0.99	531.1	4248.4
November	4	19.6	102.1	98.0	51	239.1	255.0	70	15.65	1.28	0.94	306.8	1605.9
December	3*	18.3	106.8	202.1	50	282.3	552.5	67	17.09	1.11	0.79	312.9	3405.6
1979													
January	4	36.9	188.1	218.0	102	519.0	569.5	130	12.64	0.90	0.95	466.7	2512.9
February	4	45.9	291.3	268.0	140	859.8	820.0	191	22.54	1.20	0.94	1034.6	6272.7
March	4	26.7	167.4	166.5	82	502.8	514.5	95	26.11	1.39	1.34	697.2	4627.0
April	4	38.0	233.1	293.5	114	689.1	860.0	143	22.32	1.23	1.08	848.4	7723.1
May	2*	30.7	214.7	341.3	95	632.2	1011.0	124	8.27	0.41	0.34	254.0	2621.4
June	5*	47.5	338.5	166.5	147	970.0	508.5	204	13.72	0.67	0.48	651.7	2964.9
July	4	58.3	490.5	330.0	168	1458.5	934.3	256	20.21	0.83	0.56	1178.4	9000.8
August	4	24.8	146.1	108.2	80	402.4	346.2	113	11.50	0.71	0.41	285.3	1552.2
September	3*	10.6	76.5	106.0	32	184.8	320.0	53	12.00	0.69	0.33	127.3	1042.8
TOTAL	57	508.0	3300.2	3460.6	1508	9232.9	10113.5	2013	17.66	1.03	0.82	9376.2	67141.0**

* These months the normal quota of four (4) censuses was not completed due to scheduling conflicts. Five (5) censuses were conducted in June to compensate for only two (2) in May.

** Estimated total catch adjusted for 12 months is 53,712.9 kg.

Table 2. Monthly and annual effort, catch and CPUE estimates for bottom fishing derived from data collected at the Agana Boat Basin between July 1978 and September 1979.

MONTH	NO. CENSUS DAYS	NO. BOATS TRIPS CENSUS	BOAT-HOURS	ESTIMATED MONTHLY NO. BOATS	NO. MEN	ACTUAL CENSUS MAN-HOURS	ESTIMATED MONTHLY NO. MEN	NO. LINES	CATCH/ BOAT (KG)	CATCH/ MAN-HOUR (KG)	CATCH/ LINE-HOUR (KG)	ACTUAL CENSUS CATCH (KG)	ESTIMATED MONTHLY CATCH (KG)
1978													
July	4	5.1	36.6	25.5	16	77.8	80.0	14	12.15	0.80	0.68	62.0	482.5
August	4	3.9	38.1	23.1	17	93.1	113.0	14	21.26	0.89	0.74	83.0	467.0
September	4	11.0	83.8	110.0	39	200.2	390.0	39	14.07	0.77	0.62	154.8	952.5
October	4	2.0	11.1	11.0	11	30.1	60.5	9	7.15	0.48	0.36	14.3	63.8
November	4	2.4	22.2	12.0	9	49.7	45.0	9	19.60	0.95	0.73	47.1	235.3
December	3*	1.7	14.1	20.4	4	28.2	48.0	3	11.35	0.69	1.21	19.3	231.6
1979													
January	4	0.1	1.1	0.4	3	3.2	13.5	2	3.00	0.10	0.01	0.3	1.4
February	4	1.0	8.9	8.0	2	8.9	14.0	2	17.50	1.96	1.14	17.5	161.3
March	4	0.3	1.0	1.5	2	2.0	10.0	2	38.00	5.85	1.90	11.4	57.0
April	4	0.7	6.3	3.5	5	14.8	25.0	5	16.28	0.77	0.26	11.4	57.0
May	2*	3.3	29.8	29.7	17	78.4	153.0	11	5.90	0.25	0.27	19.5	175.5
June	5*	5.5	39.6	22.5	19	94.0	72.0	31	9.51	0.56	0.23	52.3	488.1
July	4	2.7	31.1	13.5	6	62.2	30.0	8	12.77	0.55	0.43	34.5	207.0
August	4	5.1	50.1	26.4	19	122.1	85.4	19	16.59	0.69	0.51	84.7	581.9
September	3*	8.4	79.2	84.0	21	135.3	21.0	23	18.78	1.03	0.86	157.8	1292.2
TOTAL	57	53.2	453.0	391.5	190	1017.7	1160.4	191	14.93	1.09	.66	769.9	5454.1**

* These months the normal quota for four (4) censuses was not completed due to scheduling conflicts. Five (5) censuses were conducted in June to compensate for only two (2) in May.

** Estimated catch adjusted for 12 months is 4363.28 kg.

Table 3. Quarterly and annual effort, catch and CPUE estimates for spear fishing derived from data collected at the Agana Boat Basin between July 1978 and September 1979.

QUARTER	NO. CENSUS DAYS	NO. BOAT TRIPS CENSUSED	BOAT-HOURS	ESTIMATED QUARTERLY NO. BOAT TRIPS	NO. OF MEN	ACTUAL CENSUSED MAN-HOURS	ESTIMATED QUARTERLY NO. MEN	NO. SPEARS	CATCH/ BOAT (KG)	CATCH/ MAN-HOUR (KG)	CATCH/ SPEAR-HOUR (KG)	ACTUAL CENSUSED CATCH (KG)	ESTIMATED QUARTERLY CATCH (KG)
1978 July August September	12	12.8	77.8	97.1	42	223.2	312.5	38	12.92	0.80	1.58	174.4	979.4
October November December	11*	3.5	14.8	23.7	13	47.6	85.0	9	1.43	0.11	0.18	15.0	150.0
1979 January February March	12	0.1	0.5	0.4	3	1.4	13.5	1	2.50	0.18	0.06	0.8	3.4
April May June	11*	3.9	23.4	1.5	21	75.7	106.0	13	7.34	0.34	0.47	38.1	205.4
July August September	11*	0.1	0.4	0.4	7	2.5	28.0	1	0	0	0	0	0
TOTAL	57	20.4	117.0	136.6	86	350.4	545	62	4.84	0.29	0.46	228.3	1338.2**

* These quarters the normal quota of 12 censuses was not completed due to scheduling conflicts.
** Estimated total catch adjusted for 12 months is 1070.6 kg.

Table 4. Trolling, Agana Boat Basin 1978 - 1979. Monthly and annual catch census data and expanded estimates in kilograms

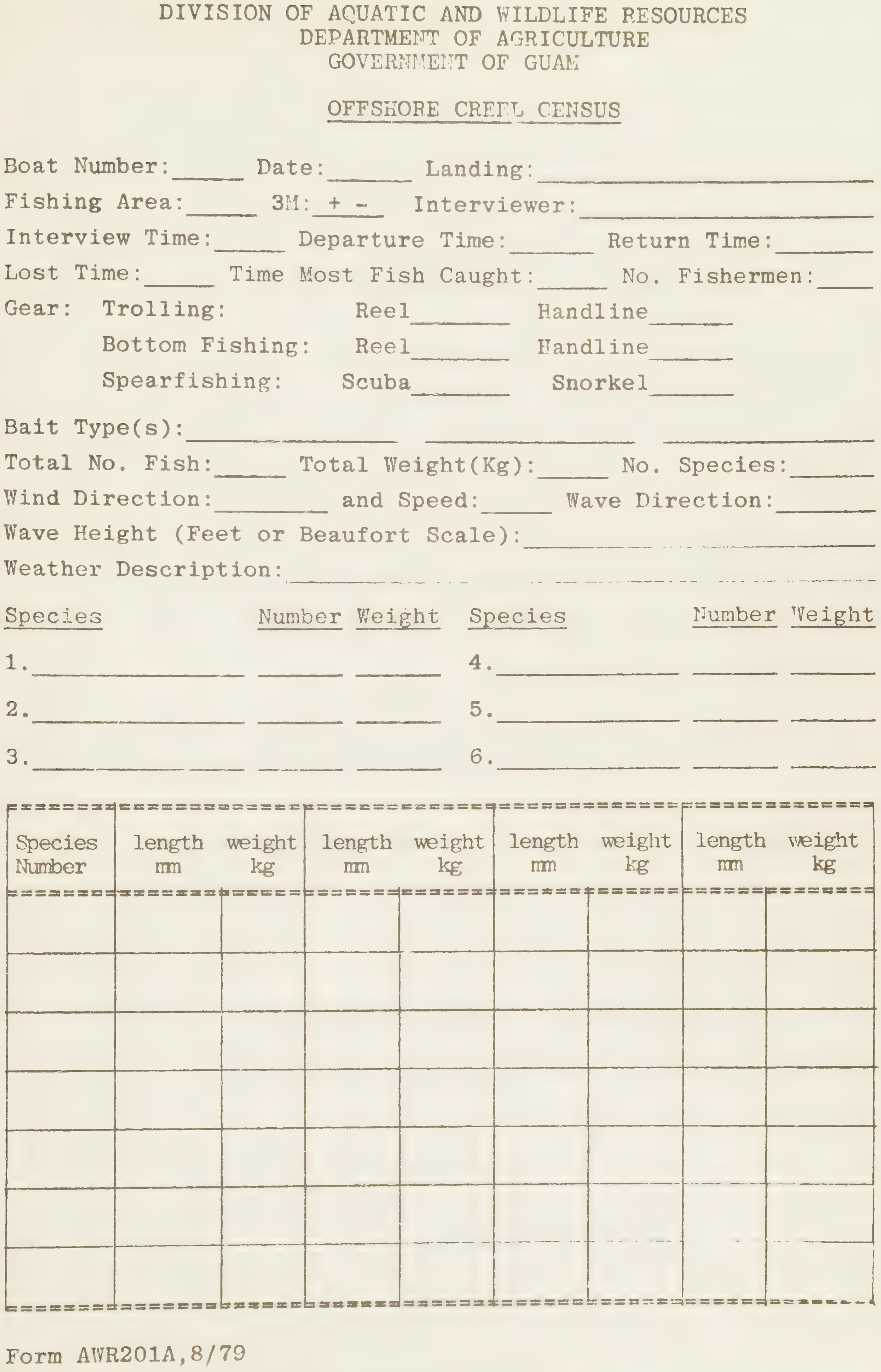
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	SUBTOTAL JUL TO JUN	JUL	AUG	SEP	SUBTOTAL OCT TO SEP	TOTAL JUL TO SEP
F. bipinnulatus																		
censused	6.4	15.4	17.1	-	-	-	-	-	-	-	4.8	17.5	61.2	14.2	8.8	-	45.3	84.2
expanded	46.9	148.6	85.5	-	-	-	-	-	-	-	44.8	65.6	391.4	96.6	42.0	-	249.0	530.0
percent	1.2	1.5	1.4	-	-	-	-	-	-	-	1.7	2.2	0.8	1.1	2.7	-	0.7	0.9
C. hippurus																		
censused	-	1.1	-	2.1	12.3	147.0	229.3	704.5	380.3	417.9	22.1	95.1	2081.7	31.6	6.3	-	2118.5	2119.6
expanded	-	4.8	-	11.6	64.4	1645.5	1493.1	4063.8	2547.2	4067.5	206.3	423.9	14528.1	215.0	30.0	-	14768.3	14773.1
percent	-	0.0	-	0.3	4.0	48.3	59.4	64.8	55.1	52.7	7.9	14.3	26.8	2.4	1.9	-	31.7	22.6
S. barracuda																		
censused	11.2	15.8	4.3	8.3	-	1.6	16.3	47.8	-	9.1	2.1	12.7	129.2	25.6	13.0	-	136.5	167.8
expanded	73.2	90.0	24.0	73.7	-	15.2	90.3	245.1	-	84.3	19.6	47.6	763.0	174.2	62.0	-	812.0	999.2
percent	1.9	0.9	0.4	0.4	-	0.4	3.6	3.9	-	1.1	0.7	1.6	1.7	1.9	4.0	-	2.0	1.8
K. pelamis																		
censused	191.8	419.7	215.6	102.0	160.9	139.2	61.8	51.5	181.5	324.3	116.7	258.0	2223.0	262.4	71.5	58.2	1788.0	2615.1
expanded	1297.8	3558.2	1339.5	885.8	842.3	1465.2	389.3	379.8	1090.1	2629.6	1305.8	967.5	16150.9	2065.3	340.9	517.1	12878.7	19074.2
percent	33.5	36.4	22.7	20.9	52.4	43.0	15.5	6.1	23.6	34.0	49.8	32.6	28.6	22.9	22.0	49.6	26.7	27.9
T. albacares																		
censused	224.8	537.8	429.2	319.1	44.2	-	26.4	99.0	24.7	45.6	26.4	131.6	1980.8	331.2	4.4	34.4	1087.0	2278.8
expanded	1807.6	4657.2	2624.0	2504.0	231.4	-	231.9	940.5	156.0	402.5	280.6	493.5	14329.2	2291.1	21.0	272.0	7824.5	16913.3
percent	46.6	47.6	44.4	58.9	14.4	-	9.2	15.0	3.4	5.2	10.7	16.6	24.5	25.5	1.4	26.1	16.3	24.3
A. solandri																		
censused	24.2	63.6	73.9	27.6	83.7	22.4	61.8	82.2	103.6	51.5	29.2	63.8	687.5	38.1	46.3	34.7	644.9	806.6
expanded	158.3	276.8	408.5	151.8	438.2	254.1	303.5	408.9	833.2	539.2	272.5	692.6	4737.6	317.9	412.6	253.6	4878.1	5721.7
percent	4.1	2.8	6.9	3.6	27.3	7.5	12.1	6.5	18.0	7.0	10.4	8.8	23.4	3.5	26.6	9.6	24.3	8.6
M. nigricans																		
censused	40.9	113.8	175.0	65.2	-	-	-	47.3	-	-	52.7	68.6	563.5	475.3	135.0	-	844.1	1173.8
expanded	427.4	832.3	1100.0	546.0	-	-	-	212.9	-	-	491.8	257.3	3867.7	3840.7	643.0	-	5992.4	8352.1
percent	11.0	8.5	18.6	12.9	-	-	-	3.4	-	-	18.8	8.7	7.2	42.7	41.5	-	12.6	12.5
Total Censused*	507.0	1217.2	957.2	531.1	306.8	312.9	446.7	1034.6	690.1	848.4	254.0	651.8	7777.8	1178.4	285.3	127.3	6687.4	9638.8
Total Estimated	3874.9	9785.5	5907.0	4248.4	1605.9	3405.6	2512.9	6272.7	4627.0	7723.1	2621.4	2964.9	55549.3	9000.8	1552.2	1042.8	47577.7	67145.1

* Totals include non-major species as well.

Table 5. Comparisons of participation, effort, catch per unit effort, and total catch estimates for the three major offshore fishing methods censused at the Agana Boat Basin during FY'79 (July 1978 - September 1979)

METHOD	NUMBER OF BOATS	%	NUMBER OF MEN	%	NUMBER OF MAN-HOURS	%	KG/MH	KG/GH	CATCH (KG)	%
Trolling	3,460.6	87	10,113.5	86	65,185.4	87	1.03	0.82	67,141.0	91
Bottom Fishing	391.5	10	1,017.7	9	5,003.8	7	1.09	.66	5,454.1	7
Spear Fishing	136.6	3	545.0	5	4,614.5	6	0.29	0.46	1,338.2	2
Total	3,988.7	100	11,676.2	100	74,803.7	100	2.41	1.94	73,933.3	100
Adjusted Total[1]	4,431.9		12,973.5		83,115.1		2.67	2.15	82,148.1	

[1] Total adjusted to 100% of effort: see first paragraph in Part F-1B.



DIVISION OF AQUATIC AND WILDLIFE RESOURCES
DEPARTMENT OF AGRICULTURE
GOVERNMENT OF GUAM

OFFSHORE CREEL CENSUS

Boat Number: ____ Date: ____ Landing: ____

Fishing Area: ____ 3M: + - Interviewer: ____

Interview Time: ____ Departure Time: ____ Return Time: ____

Lost Time: ____ Time Most Fish Caught: ____ No. Fishermen: ____

Gear: Trolling: Reel ____ Handline ____

Bottom Fishing: Reel ____ Handline ____

Spearfishing: Scuba ____ Snorkel ____

Bait Type(s): ____ ____ ____

Total No. Fish: ____ Total Weight(Kg): ____ No. Species: ____

Wind Direction: ____ and Speed: ____ Wave Direction: ____

Wave Height (Feet or Beaufort Scale): ____

Weather Description: ____

Species	Number	Weight	Species	Number	Weight
1.			4.		
2.			5.		
3.			6.		

Species Number	length mm	weight kg	length mm	weight kg	length mm	weight kg	length mm	weight kg

Form AWR201A,8/79

Figure 1. Offshore Creel Census Form.

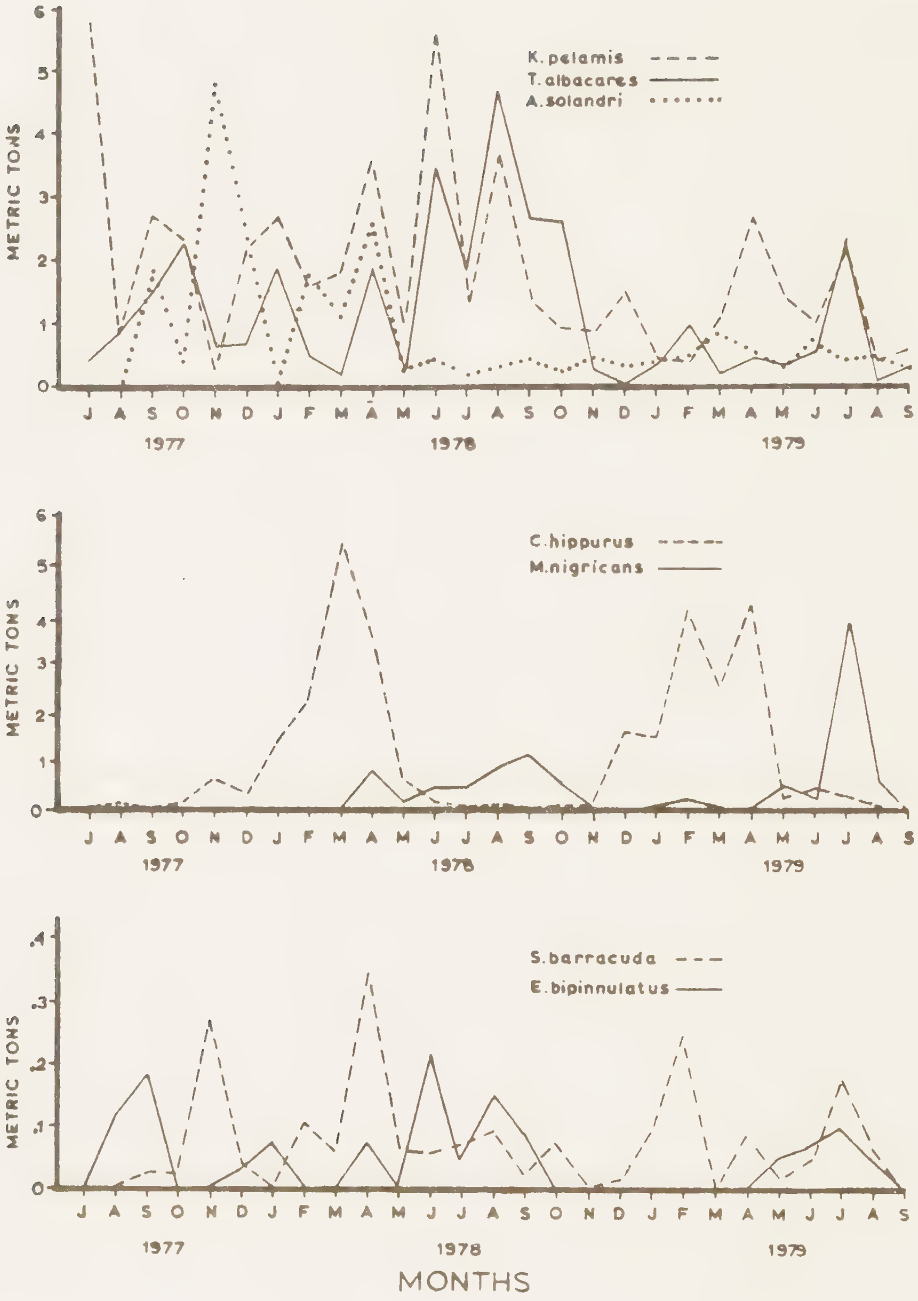


Figure 2. Estimated monthly landings of the seven major trolling species caught off Guam between July 1977 and September 1979.

F-1C Inshore Fishing

During this 15-month report period 88 out of 90 scheduled inshore creel censuses were completed. The censuses were conducted over the same routes which have been used for the last several years, as shown in Figure 1. Each route is censused twice per month, once on a weekday and once on a holiday, on dates chosen by lottery. No two routes are censused on the same day. The major inshore fishing methods include hook and line fishing, cast netting, gill netting, surround netting, and spearfishing. In addition, octopi, lobsters, crabs, and shellfish are harvested by hand or with hooks or short spears.

The inshore effort and catch data taken during FY 1979 for the five major inshore fishing methods are given in Tables 1a-5a. The expanded monthly, annual, and total estimates for each method are presented in Table 1b-5b. Table 6 summarizes the participation, effort, catch per unit effort (CPUE), and catch for the five methods. Of these, hook and line fishing was the most popular method, being responsible for 44% of the participation and 45% of the effort expended during the 15-month report period. In terms of effectiveness, however, hook and line fishing ranked last with a CPUE of 0.11 kg/gear-hour. Gill netting ranked second in both participation and effort, followed rather closely by surround and cast netting. The largest catch was attributed to surround netting which had the highest CPUE value of 5.12 kg/gear-hour. Taken together, gill and surround netting accounted for close to 63% of the harvest attributed to the five methods.

Overall, holiday participation and effort was found to be 2.7 and 2.5 times, respectively, as great as was that for weekdays. By method, the ratios of effort on holidays to that on weekdays were as follows: cast netting - 1.2:1; hook and line fishing - 2.0:1; spearfishing - 3.3:1; surround netting - 3.3:1; and gill netting - 3.8:1.

Two annual harvest estimates are provided in Table 6; one for the months of July 1978 through June 1979, and the other for the months of October 1978 through September 1979. These estimated harvests which are 10,945 kg and 10,076 kg, respectively, are very close in value to the annual harvest estimated for FY 1978 (see Addendum). During the entire 15-month report period a harvest of 12,465 kg is attributed to the five major methods alone.

In addition, 86 persons were interviewed while they were taking some 46 kg of octopi from the reef flats during approximately 102 hours of fishing effort. From this information it was estimated that 380 persons spent nearly 856 hours harvesting almost 465 kg of octopi during FY 1979. This yields a CPUE of 0.54 kg/person-hour. It was emphasized in last year's report, that this method is highly tide-dependent, and creel censuses are conducted independently of tide levels, so these estimates should most certainly be considered as minimums.

Another group of 74 persons were interviewed while harvesting shellfish, primarily the topshell *Trochus niloticus*. These people harvested 178 kg in approximately 89 hours, yielding total FY 1979 estimates of 1661 kg harvested in 1,472 person-hours (357 group-hours), of effort by 378 people. We also estimate that at least another 100 kg of crustaceans and algae were harvested by 125 people in nearly 460 hours of effort.

The atulai (Trachurops crumenopthalmus) harvest during FY 1979 was estimated to be about 50% higher than that of FY 1978. This estimate is based on the run which occurred during the summer and fall of 1979 only. A total of 30 pickup-truck loads of atulai were reported landed at various locations around the island including the Agana Boat Basin, Apra Harbor, Umatac, Merizo, and Inarajan. If each truckload represents 1,100 kg, the harvest totaled approximately 15,000 kg.

The manahac (Siganus spinus) run was very light again this year. Only 2 kg of manahac showed up in our creel censuses during FY 1979. This makes the second year in a row that the run was surprising light. Last year (FY 1978) only 25 kg appeared on our censuses while during FY 1977 we censused 4,500 kg. It was suggested in last year's annual report that steps might have to be taken to protect this species during their recruitment runs. While this may be sound management, it will not be easy to accomplish since the manahac is a traditionally and culturally important food fish among Guamanians in general. To compound the problem, the harvesting of manahac is often a family event that is anticipated for months by many. It appears that this unusually delicate problem should be addressed in the near future to at least outline the options that are available in the event that a management course of action be deemed appropriate. Regulating the surround netting harvest of adult S. spinus during the months of January, February, and March may be one such option.

To summarize our estimates of Guam's FY 1979 (15-month) inshore harvest, we can include the following: 12,465 kg of finfish harvested by the five major inshore fishing methods; 15,000 kg of atulai; 1,661 kg of shellfish; 465 kg of octopi; and 100 kg of crustaceans and algae. This totals 29,691 kg. If we add to this figure another estimated 8,745 kg of finfish caught through the use of fish weirs, our total estimated 15-month harvest for FY 1979 is 38,436 kg or 38 metric tons.

Our data on each of the five inshore methods were also examined for seasonal trends in participation, catch, and CPUE during FY 1979. Participation comparisons are shown in Figure 2. The hook and line method appeared to be a popular late summer activity, while cast netting attracted more people during the early (April/May) and late (August/September) expected manahac runs. Surround netting peaked during the late winter/early spring months. Overall, fishing was found to be the heaviest during the late summer months.

Our catch data in Figure 3 showed nearly the same trends for hook and line fishing, cast netting, and surround netting, as did participation. The large late winter/early spring surround net catch consisted primarily of adult S. spinus. The unusually high (and misleading) gill net catch in May is attributed to the fortuitous netting of a large school of guile (Kyphosus cinerascens). Overall, the majority of the inshore catch was harvested between the months of December '78 and July '79.

Figure 4 compares the monthly CPUE values for the five major inshore fishing methods and overall. The best catch rates for hook and line fishing were recorded for the winter months of November and December '78. Surround netting showed an obvious peak in CPUE during January, February, and March. Spearfishing and cast netting also contributed high rates during January and February, respectively. The combined effect resulted in definite CPUE maximums during the winter months from December through March. The CPUE for spearfishing appears to fluctuate randomly throughout the period, but this is probably largely due to the fact that much of the spearfishing catch is landed late at night and is not censused.

Inshore-Offshore Synthesis

The estimated participation, effort, and catch for Guam's total fishing activity during our 15-month FY 1979 creel census period is as follows:

Participation:	12,974	(offshore; 58%)
	+ 9,236	(inshore; 42%)
	22,210	persons or individual fishing trips
Effort:	83,115	(offshore; 70%)
	+36,036	(inshore; 30%)
	119,151	person-hours
Catch:	82,148	(offshore; 68%)
	+38,436	(inshore; 32%)
	120,584	Kg

Our best estimates are approximately double the above figures, or approximately 44,420 persons having spent 238,302 hours (29,788 person-days) harvesting 241,168 kg or about 241 metric tons.

Report prepared by: Michael E. Molina

Table 1a. Hook and line fishing creel census data summarized by month, and for fiscal year 1979.

	Number of Persons	Number Groups	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
July	46	26	63.06	42	61.55	5.05
August	131	58	315.75	114	346.38	29.52
September	93	55	184.42	95	164.31	15.99
October	70	32	168.14	70	164.89	3.96
November	38	23	44.60	40	43.19	9.49
December	45	21	79.87	51	88.03	15.75
January	50	30	79.03	49	77.41	8.58
February	35	22	43.00	37	43.59	6.39
March	37	26	82.66	38	84.59	3.07
April	21	12	36.70	23	46.70	1.75
May	21	17	25.15	21	19.72	1.44
June	36	22	103.79	34	92.53	13.62
SUB-TOTAL (JUL.-JUN.)	623	344	1,226.17	614	1,232.89	114.61
July	39	24	97.82	38	83.42	10.43
August	73	36	118.58	75	125.71	22.46
September	86	39	254.29	86	223.65	31.00
SUB-TOTAL (OCT.-SEPT.)	551	304	1,133.63	562	1,093.43	127.94
TOTAL	821	443	1,696.86	813	1,665.67	178.50

Table 1b. Hook and line fishing data expanded from Table 1a to yield total monthly and annual estimates for fiscal year 1979.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	208	843	769	0.08	0.08	64
August	618	2,529	2,122	0.09	0.08	199
September	390	1,464	1,459	0.09	0.10	139
October	284	1,360	1,396	0.02	0.02	28
November	160	656	674	0.22	0.22	146
December	217	873	959	0.20	0.18	174
January	163	568	568	0.11	0.11	62
February	162	641	656	0.15	0.15	97
March	163	665	684	0.04	0.04	27
April	117	477	504	0.05	0.04	22
May	80	363	299	0.06	0.07	21
June	152	677	668	0.13	0.15	94
SUB-TOTAL (JUL-JUN)	2,714	11,116	10,758	0.10	0.10	1,073
July	244	1,190	1,103	0.11	0.12	132
August	305	1,009	1,048	0.19	0.18	190
September	371	1,748	1,704	0.12	0.14	224
SUB-TOTAL (OCT-SEPT)	2,418	10,227	10,263	0.10	0.12	1,217
TOTAL	3,634	15,063	14,613	0.11	0.11	1,619

Table 2a. Cast net fishing creel census data summarized by month, and for fiscal year 1979.

	Number of Persons	Number Groups	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
July	13	11	10.75	12	10.50	5.33
August	32	26	37.06	28	35.41	7.50
September	19	16	34.48	16	28.57	5.53
October	14	12	20.22	14	19.32	2.56
November	12	11	7.33	12	6.98	1.57
December	8	4	6.15	7	5.90	1.09
January	11	10	13.76	10	11.93	2.91
February	13	10	26.99	12	21.24	18.79
March	5	4	6.32	4	5.83	2.36
April	12	10	26.32	12	26.32	12.51
May	37	29	52.81	33	44.39	14.18
June	29	22	60.30	29	55.86	16.35
SUB-TOTAL (JUL.-JUN.)	205	165	302.49	189	272.25	90.68
July	10	7	20.48	8	15.66	20.81
August	7	6	12.40	6	9.15	2.49
September*	11	7	13.99	8	13.16	2.85
SUB-TOTAL (OCT.-SEPT.)	169	132	267.07	155	235.74	98.47
TOTAL	233	185	349.36	211	310.22	116.83

Table 2b. Cast net fishing data expanded from Table 2a to yield total monthly and annual estimates for fiscal year 1979.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	63	106	100	0.51	0.51	52
August	195	513	460	0.20	0.21	100
September	75	212	167	0.16	0.19	33
October	59	167	274	0.13	0.13	29
November	56	142	141	0.21	0.22	30
December	60	86	77	0.18	0.18	15
January	59	121	105	0.21	0.24	25
February	56	160	124	0.70	0.88	111
March	24	51	47	0.37	0.40	19
April	70	232	335	0.48	0.48	136
May	198	633	844	0.27	0.40	254
June	119	397	633	0.27	0.29	145
SUB-TOTAL (JUL-JUN)	1,034	2,820	3,307	0.34	0.29	949
July	49	144	119	1.02	1.33	153
August	44	115	90	0.02	0.27	24
September	51	164	161	0.02	0.22	34
SUB-TOTAL (OCT-SEPT)	845	2,412	2,950	0.40	0.33	975
TOTAL	1,178	3,243	3,677	0.36	0.31	1,160

Table 3a. Gill net fishing creel census data summarized by month, and for fiscal year 1979.

	Number of Persons	Number Groups	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
July	42	14	141.66	17	39.33	9.89
August	61	26	129.98	37	11.39	37.44
September	31	15	55.21	14	22.57	18.11
October	30	9	106.68	24	79.61	29.37
November	8	4	5.74	4	5.33	3.20
December	7	6	31.17	16	58.60	12.41
January	11	7	10.33	9	14.74	6.83
February	23	9	37.67	18	31.67	21.06
March	25	13	51.43	24	43.67	22.21
April	10	5	5.00	5	2.25	0.50
May	24	8	33.65	8	13.74	94.67
June	32	12	64.22	12	27.58	24.04
SUB-TOTAL (JUL.-JUN.)	304	128	672.74	188	350.48	279.73
July	38	11	133.69	11	38.49	47.30
August	19	11	49.18	12	45.67	9.95
September	30	11	50.08	16	31.99	22.33
SUB-TOTAL (OCT.-SEPT.)	257	106	578.84	159	393.34	293.87
TOTAL	391	161	905.69	227	466.63	359.31

Table 3b. Gill net fishing data expanded from Table 3a to yield total monthly and annual estimates for fiscal year 1979.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	193	783	275	0.07	0.25	62
August	218	630	469	0.29	3.28	860
September	143	420	200	0.33	0.80	149
October	142	983	643	0.27	0.37	252
November	32	109	55	0.56	0.60	47
December	20	160	421	0.40	0.21	76
January	33	131	98	0.66	0.46	66
February	76	269	292	0.56	0.66	172
March	84	332	413	0.43	0.51	177
April	58	150	80	0.10	0.22	16
May	102	476	163	2.81	0.89	1,230
June	132	441	173	0.37	1.15	181
SUB-TOTAL (JUL-JUN)	1,234	4,884	3,282	0.67	1.00	3,288
July	146	719	249	0.35	0.81	227
August	91	370	269	0.20	0.22	67
September	142	620	284	0.45	0.70	239
SUB-TOTAL (OCT-SEPT)	1,059	4,760	3,140	0.58	0.88	2,750
TOTAL	1,613	6,593	4,084	1.72	0.94	3,821

Table 4a. Surround net fishing creel census data summarized by month, and for fiscal year 1979.

	Number of Persons	Number Groups	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
July	5	1	0.40	1	0.00	0.00
August	9	1	4.50	2	0.00	0.00
September	10	1	30.00	1	3.00	21.12
October	13	4	15.44	3	2.92	8.70
November	26	3	14.69	3	2.42	4.25
December	36	4	25.94	4	2.83	14.70
January	24	4	60.99	4	9.00	86.75
February	86	7	136.75	7	11.50	135.24
March	50	6	65.69	6	6.75	64.10
April	0	0	0.00	0	0.00	0.00
May	7	1	32.06	1	4.58	2.01
June	27	4	46.00	4	5.00	9.10
SUB-TOTAL (JUL.-JUN.)	293	36	432.46	36	48.00	345.97
July	18	2	40.58	2	4.99	9.50
August	0	0	0.00	0	0.00	0.00
September	6	1	31.98	1	5.00	6.20
SUB-TOTAL (OCT.-SEPT.)	293	36	470.12	35	54.99	340.55
TOTAL	317	39	505.02	39	57.99	361.67

Table 4b. Surround net fishing data expanded from Table 4a to yield total monthly and annual estimates for fiscal year 1979.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	33	100	20	0.00	0.00	88*
August	24	60	13	0.00	0.00	55*
September	33	165	18	0.70	7.04	121
October	39	148	32	0.56	2.98	89
November	104	548	56	0.29	1.76	129
December	144	779	81	0.57	5.19	432
January	131	614	96	1.42	9.64	900
February	285	1,777	154	0.99	11.76	962
March	163	835	98	0.98	9.50	875
April	0	0	0	0.00	0.00	0
May	21	105	15	0.06	0.44	6
June	109	492	84	0.20	1.82	126
SUB-TOTAL (JUL-JUN)	1,086	5,623	667	0.67	5.67	3,783
July	90	789	93	0.23	1.90	179
August	0	0	0	0.00	0.00	0
September	22	85	18	0.19	1.24	19
SUB-TOTAL (OCT-SEPT)	1,108	6,172	727	0.60	5.11	3,717
TOTAL	1,198	6,497	778	0.61	5.12	3,981

*Catch based on mean catch rates derived from September 1978 through June 1979 data.

Table 5a. Spearfishing creel census date summarized by month, and for fiscal year 1979.

	Number of Persons	Number Groups	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
July	14	7	11.66	13	8.34	4.44
August	20	13	19.06	21	17.27	35.12
September	15	7	11.24	15	9.99	2.42
October	12	7	18.32	12	15.82	2.14
November	3	1	0.00	3	0.00	0.00
December	2	1	1.00	2	1.00	0.00
January	5	4	5.17	5	2.92	10.20
February	8	4	8.75	8	4.25	2.09
March	38	10	86.41	38	77.92	27.13
April	6	2	4.67	6	4.33	16.90
May	17	6	43.50	15	34.00	38.20
June	17	8	54.33	16	46.75	84.81
SUB-TOTAL (JUL.-JUN.)	157	70	264.11	154	222.59	223.45
July	17	8	22.82	17	22.49	9.30
August	0	0	0.00	0	0.00	0.00
September	2	2	1.33	2	1.00	0.57
SUB-TOTAL (OCT.-SEPT.)	127	53	246.30	124	210.48	191.34
TOTAL	176	80	288.26	173	246.08	233.32

Table 5b. Spearfishing data expanded from Table 5a to yield total monthly and annual estimates for fiscal year 1979.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	66	105	70	0.38	0.53	38
August	87	214	199	1.84	2.03	399
September	54	136	132	0.21	0.24	30
October	45	89	82	0.12	0.14	11
November	18	18	18	0.00	0.00	44*
December	8	16	16	0.00	0.00	39*
January	19	38	41	1.97	3.49	109
February	31	70	56	0.24	0.49	22
March	123	341	297	0.31	0.37	216
April	33	59	57	3.62	3.90	218
May	99	360	300	0.88	1.12	326
June	67	255	222	1.56	1.81	400
SUB-TOTAL (JUL-JUN)	650	1,701	1,490	1.09	1.24	1,852
July	66	145	150	0.20	0.20	30
August	0	0	0	0.00	0.00	0
September	7	9	7	0.22	0.28	2
SUB-TOTAL (OCT-SEPT)	516	1,400	1,246	1.01	1.14	1,417
TOTAL	723	1,855	1,647	1.02	1.14	1,884

*Catch based on mean catch rates derived from July through October 1978 and January through June 1979 data.

Table 6. Participation, effort, CPUE, and total catch figures for the five major inshore fishing methods during fiscal year 1979 (July '78 - September '79).

Fishing Method	Number Persons	%	Number Person-Hours	%	Kg/PH 1/	Kg/GH 2/	Catch (Kg)	%
Hook & Line:								
Jul - Jun	2,714	40	11,116	42	0.10	0.10	1,073	10
Oct - Sept	2,418	40	12,527	45	0.10	0.12	1,217	12
Jul - Sept	3,634	44	15,063	45	0.11	0.11	1,619	13
Cast Net:								
Jul - Jun	1,034	16	2,820	11	0.34	0.29	949	9
Oct - Sept	845	14	2,412	10	0.40	0.33	975	10
Jul - Sept	1,178	14	3,243	10	0.36	0.31	1,160	9
Gill Net:								
Jul - Jun	1,233	18	4,884	19	0.67	1.00	3,288	30
Oct - Sept	1,058	18	4,760	17	0.58	0.88	2,750	27
Jul - Sept	1,612	19	6,593	20	1.72	0.94	3,821	31
Surround Net:								
Jul - Jun	1,086	16	5,623	21	0.67	5.67	3,783	34
Oct - Sept	1,108	19	6,172	23	0.60	5.11	3,717	37
Jul - Sept	1,198	14	6,497	19	0.61	5.12	3,981	32
Spearfishing:								
Jul - Jun	650	10	1,701	7	1.09	1.24	1,852	17
Oct - Sept	516	9	1,400	5	1.01	1.14	1,417	14
Jul - Sept	723	9	1,855	6	1.02	1.14	1,884	15
TOTAL:								
Jul - Jun	6,717	100	26,144	100	0.42	0.56	10,945	100
Oct - Sept	5,945	100	27,271	100	0.37	0.55	10,076	100
Jul - Sept	8,345	100	33,251	100	0.38	0.50	12,465	100

1/ PH = person-hour
2/ GH = gear-hour

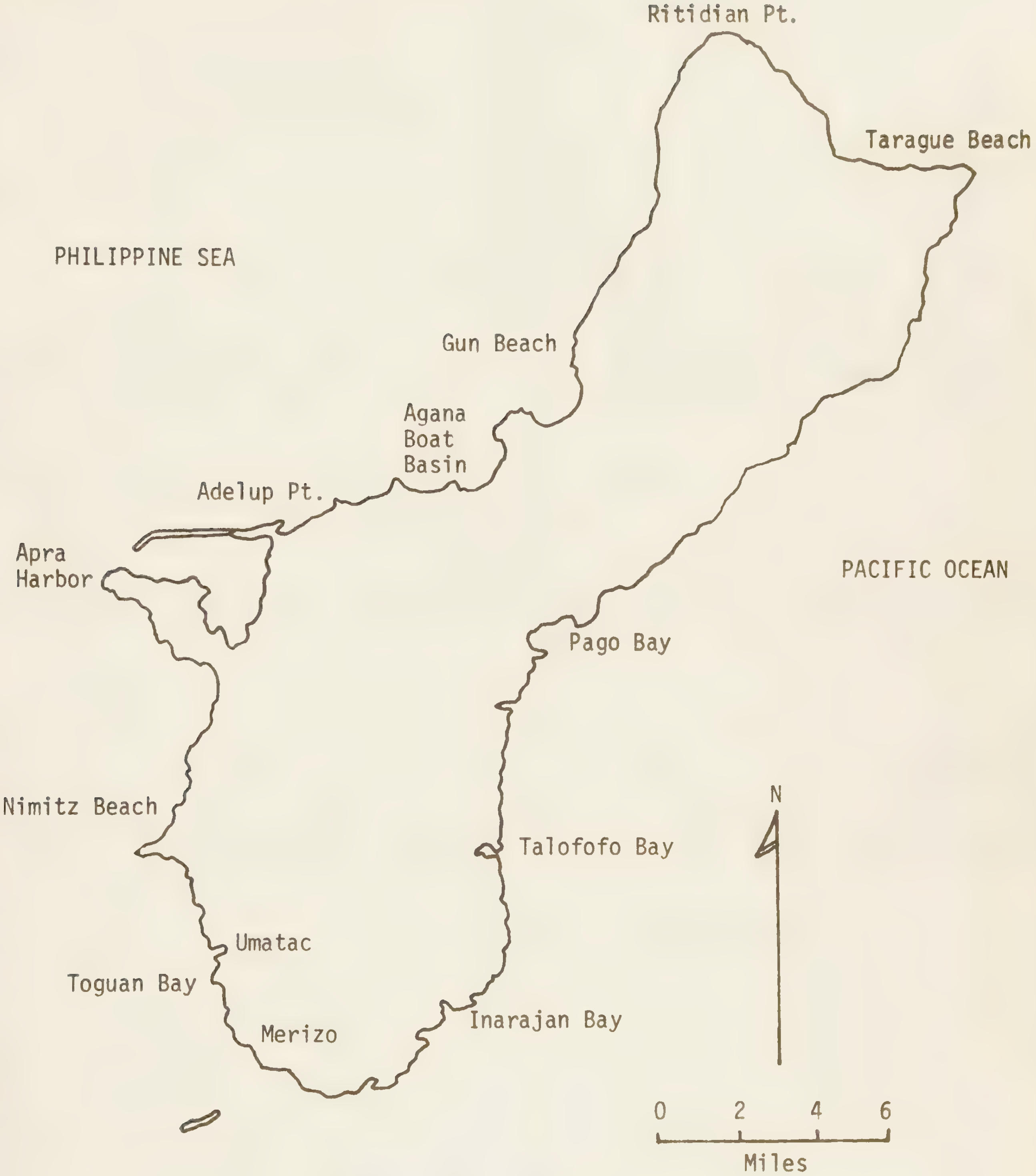

Ritidian Pt.
Tarague Beach
PHILIPPINE SEA
Gun Beach
Agana Boat Basin
Adelup Pt.
Apra Harbor
PACIFIC OCEAN
Pago Bay
Nimitz Beach
Talofofo Bay
N
Umatac
Toguan Bay
Merizo
Inarajan Bay
0
2
4
6
Miles

Figure 1. The island of Guam. The Inshore Fishing Census Regions are as follows:
Region #1 - Gun Beach to Adelup Pt.
Region #2 - Adelup Pt. to Nimitz Beach
Region #3 - Toguan Bay to Pago Bay

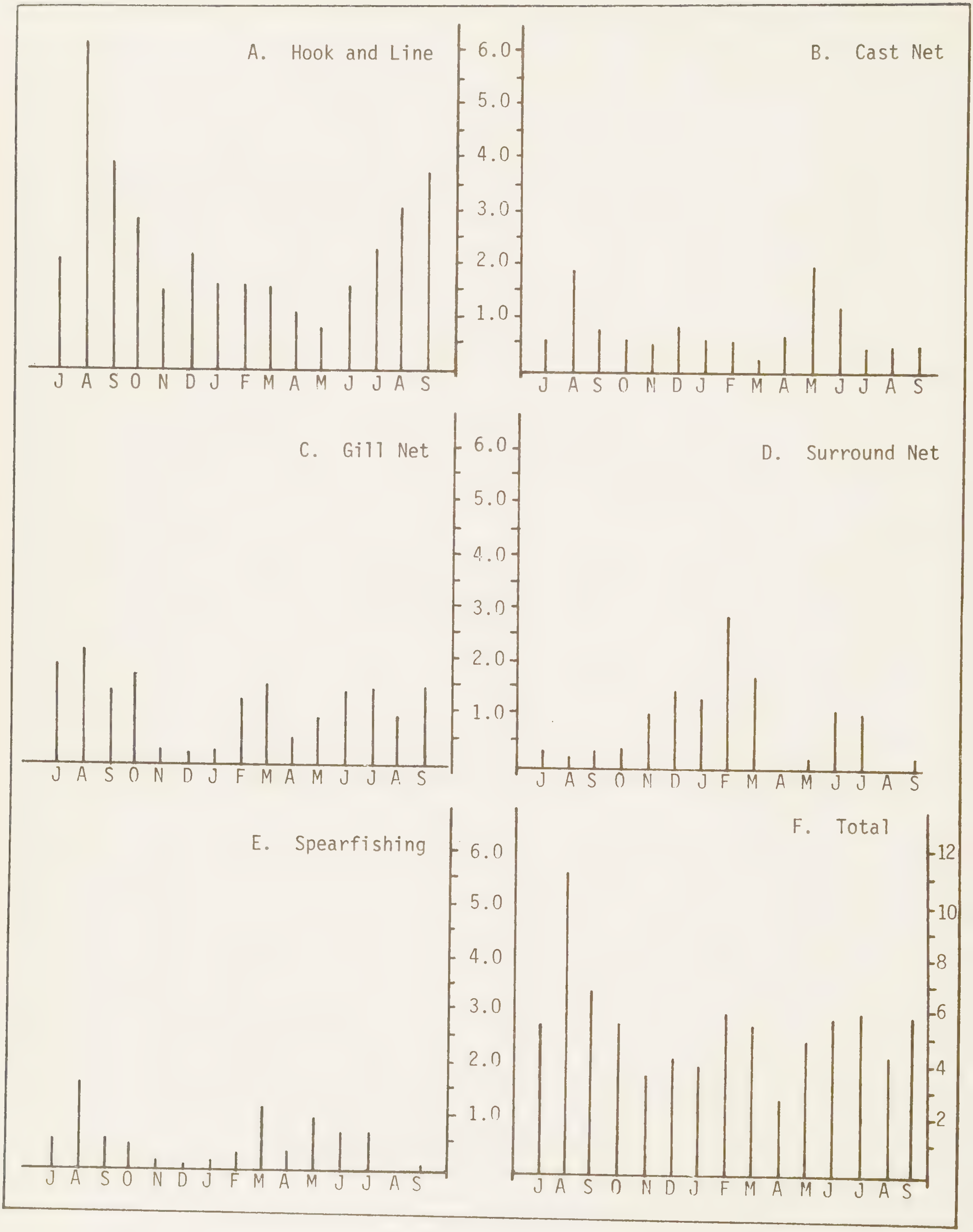


Figure 2. Monthly fishing participation in hundreds of persons by gear type and overall for fiscal year 1979.

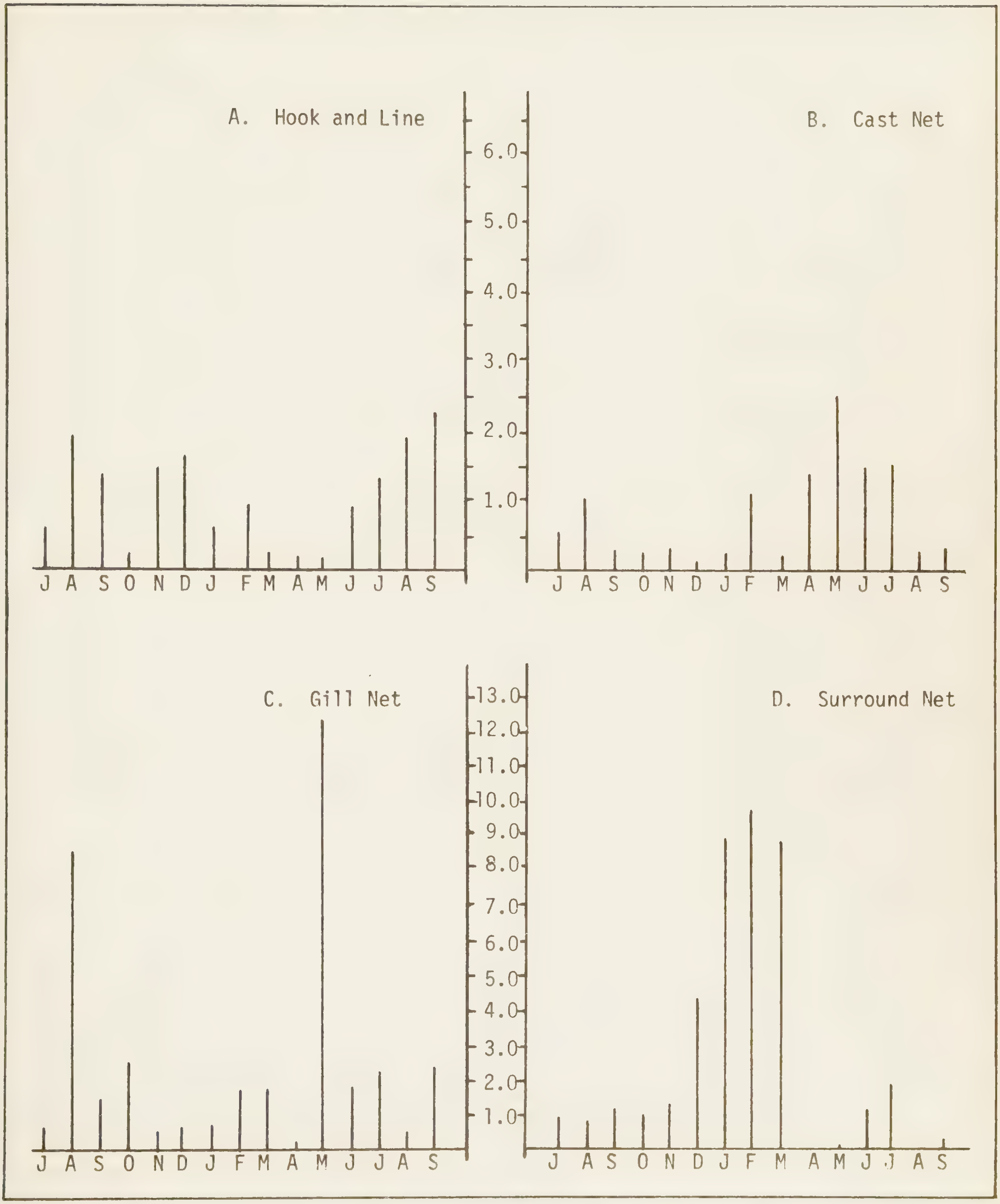
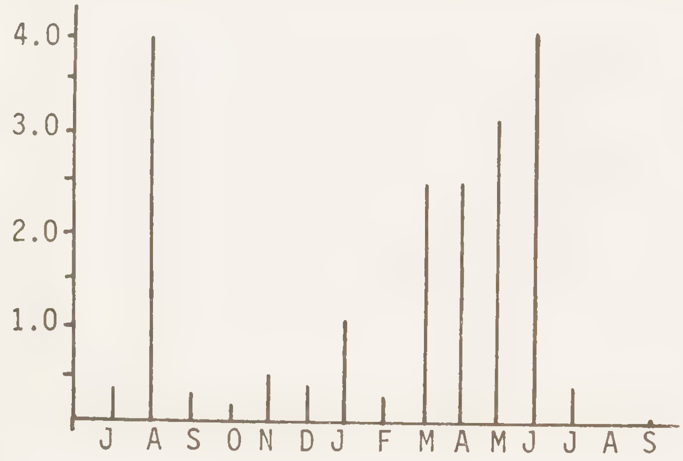
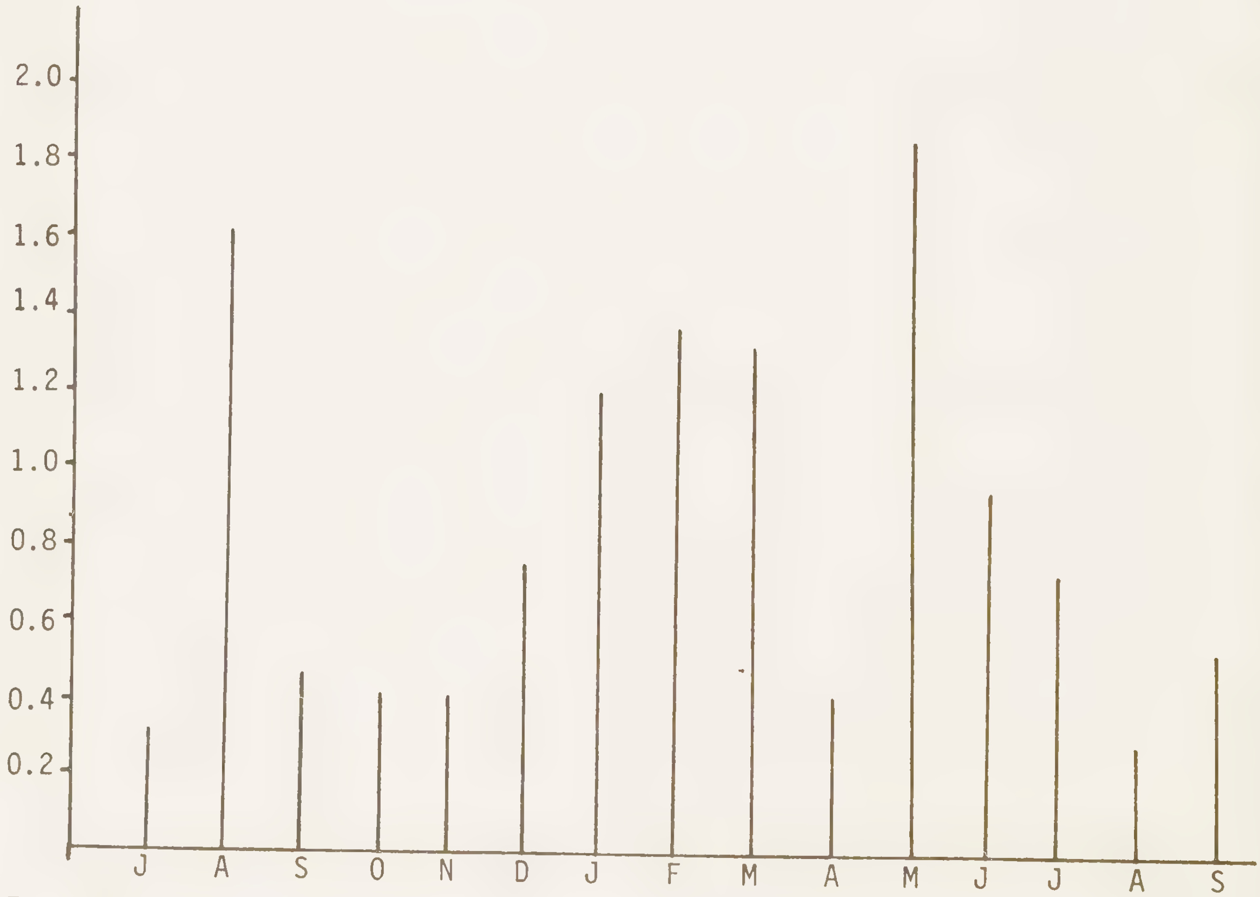


Figure 3. Monthly trends in catch in hundreds of Kilograms for the five major inshore fishing methods during fiscal year 1979.



E. Spearfishing



F. Total

Figure 3. (continued) The monthly catch for all methods for the five methods combined (F. Total) is measured in metric tons.

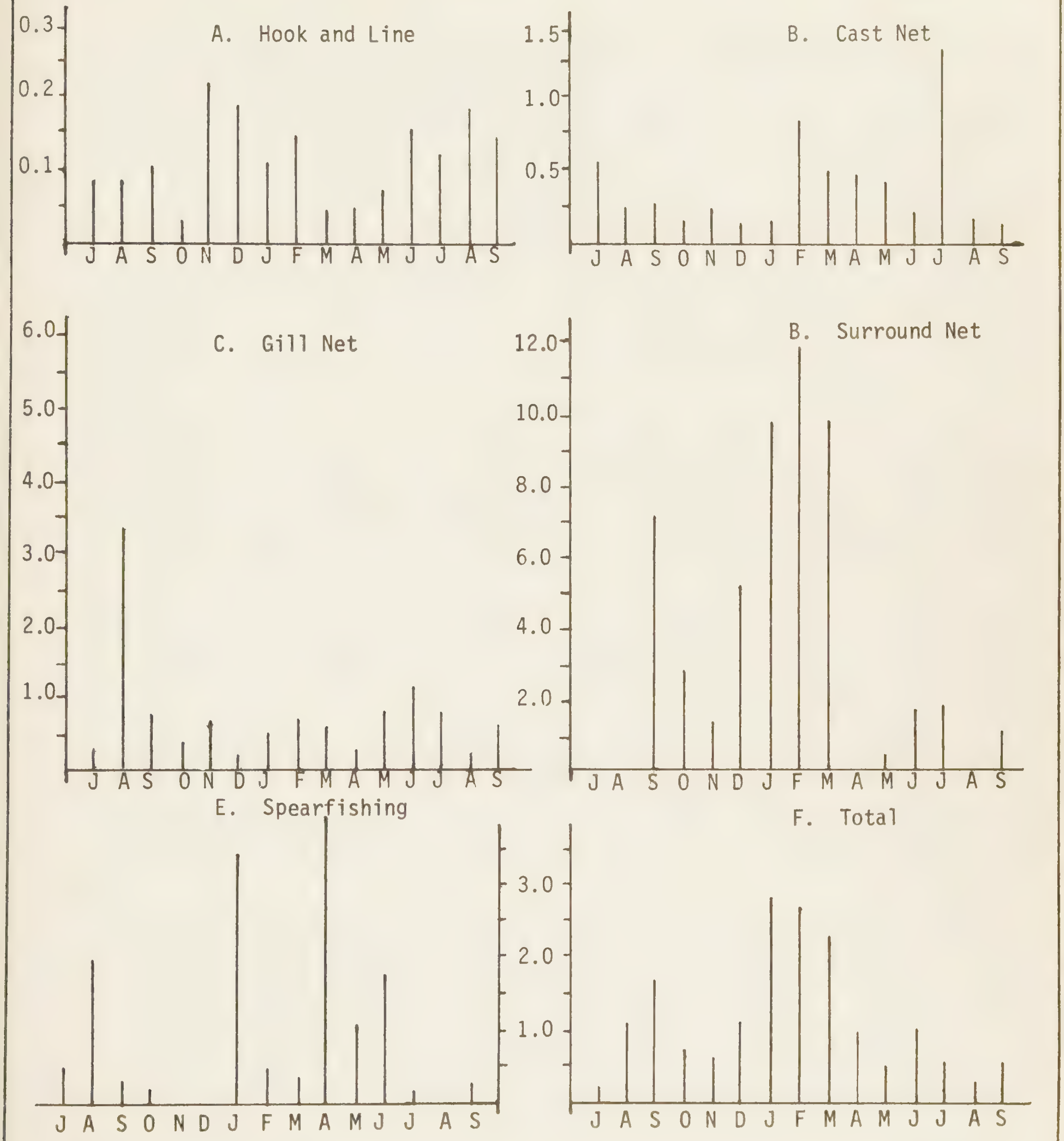


Figure 4. Catch per unit effort (CPUE) for the five major inshore fishing methods and overall. CPUE is calculated as Kg/gear-hour.

F-1C-Addendum

Regrettably, our estimates of last year's inshore fishing activity were in error. A correction factor which should have been applied to the data early in the analysis was overlooked, resulting in rather uniform overestimates of approximately 200 percent. Tables 1b-5b and 6 in this addendum should replace the correspondingly numbered tables in the FINDINGS section of job F-1A-Inshore Fishing in our annual report for FY 1978. The first five tables summarize the monthly and annual effort and catch estimates for the five most popular inshore fishing methods employed on Guam. Table 6 compares participation, effort, CPUE, and total catch for these methods. Since the error had such a uniform effect, the percentages in this table remained relatively unchanged. The total estimated annual harvest attributed to these methods is 10,182 kg. Addendum Figures 1 through 3 are replacements for Figures 2 through 4, respectively, which were published in last year's report, job F-1A-Inshore Fishing. As before, all our estimates should be considered as minimum values.

The atulai, manahac, and fish weir annual estimates were unaffected by the error and did not require correction. However, those concerning the harvesting of octopi and shellfish had to be recalculated. The results for octopus fishing are as follows: participation = 540 persons; effort = 1,324 person-hours; catch = 702 kg; CPUE = 0.53 kg/person-hour. The annual estimates for the harvesting of shellfish are follows: participation = 367 persons; effort = 1,230 person-hours; catch = 3,075 kg; CPUE = 2.50 kg/person-hour.

Therefore, the corrected minimum estimate of Guam's inshore harvest for FY 1978 based on our creel census data includes the following: 34,707 kg of finfish, 702 kg of octopi, and 3,074 kg of shellfish. This represents an annual inshore harvest of approximately 38,500 kg.

As a consequence, these corrections necessitated a re-evaluation of Guam's total inshore - offshore fishing estimates for FY 1978. Total participation is estimated to have been approximately 18,000 persons of which 45 and 55 percent employed inshore and offshore methods, respectively. A total effort of nearly 88,000 person hours (27% inshore; 73% offshore) resulted in a total estimated harvest of approximately 142,225 kg. (27% inshore; 73% offshore).

To clarify, the estimates for participation given as numbers of persons are are also representative of the estimated number of fishing trips which were made. Also, a person-day is interpreted here as being the same as an 8-hour workday. Thus, 88,000 person-hours translates into 11,000 person-days of effort. Since our best estimates of island-wide effort and catch are approximately double the above values, our FY 1978 12-month harvest of approximately 284,500 kg required nearly 22,000 person-days of effort. This information should replace that given in paragraph two of the Inshore-Offshore Synthesis part of job F-1B-Offshore Fishing (p. 37) of last year's annual report.

Report prepared by : Michael E. Molina

Table 1b. Hook and line fishing; fiscal year 1978.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	327	1,191	1,236	0.22	0.21	261
August*	182	590	631	0.21	0.20	125
September	166	611	611	0.38	0.38	232
October	151	557	689	0.15	0.10	76
November	220	691	733	0.29	0.30	210
December	151	497	520	0.31	0.29	152
January	239	748	813	0.21	0.18	152
February	215	652	662	0.14	0.14	92
March	107	265	284	0.06	0.06	16
April	53	197	203	0.01	0.01	2
May	83	296	366	0.02	0.02	7
June	122	253	255	0.25	0.24	62
TOTAL	2,016	6,548	7,003	0.21	0.20	1,387

*The August estimates are derived as explained under the section entitled Findings in the FY'78 report.

Table 2b. Cast Net fishing; fiscal year 1978.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	31	72	72	0.65	0.65	50
August*	94	226	190	0.57	0.67	128
September	41	75	58	2.17	2.97	168
October	126	313	256	0.95	1.06	284
November	84	183	180	0.78	0.79	142
December	96	263	180	0.44	0.59	111
January	139	300	300	0.35	0.35	105
February	28	54	45	0.42	0.54	24
March	70	169	162	0.46	0.50	79
April	67	139	122	0.78	0.83	105
May	151	415	341	0.19	0.23	78
June	119	298	208	0.29	0.62	147
TOTAL	1,046	2,507	2,114	0.57	0.67	1,421

Table 3b. Gill Net fishing; fiscal year 1978.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	155	652	348	0.11	0.22	74
August*	184	602	242	0.46	1.14	276
September	164	510	206	1.06	2.55	533
October	163	543	268	0.87	1.78	475
November	104	344	123	0.60	1.77	212
December	171	427	199	0.98	2.27	435
January	137	495	223	0.37	0.76	176
February	122	253	111	0.66	1.83	185
March	256	868	209	0.09	0.48	89
April	200	854	312	0.37	1.42	380
May	254	806	325	0.22	0.45	162
June	135	331	121	0.19	0.57	66
TOTAL	2,045	6,685	2,687	0.46	1.14	3,063

Table 4b. Surround Net fishing; fiscal year 1978.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	102	479	64	1.00	6.67	453
August*	72	339	45	1.00	6.67	320
September	60	282	37	1.00	6.67	264
October	78	367	41	1.00	6.67	320
November	45	212	37	1.00	6.67	229
December	61	287	41	1.00	6.67	280
January	91	423	41	1.00	6.67	348
February	67	315	37	1.00	6.67	281
March	24	113	41	1.00	6.67	193
April	73	343	41	1.00	6.67	308
May	94	442	41	1.00	6.67	358
June	41	193	37	1.00	6.67	220
TOTAL	808	3,795	503	1.00	6.67	3,574

Table 5b. Spearfishing; fiscal year 1978.

	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
July	47	113	113	0.14	0.24	22
August*	66	159	150	0.40	0.42	63
September	39	94	72	0.17	0.30	19
October	77	185	94	0.52	0.52	72
November	73	175	161	0.57	0.67	104
December	94	226	175	0.42	0.42	84
January	62	149	226	0.32	0.32	60
February	58	139	132	0.77	0.77	104
March	30	72	139	0.61	0.61	64
April	73	175	168	0.07	0.07	12
May	37	89	72	1.48	1.48	119
June	87	209	178	0.07	0.07	14
TOTAL	743	1,785	1,680	0.40	0.42	737

Table 6. Annual participation, effort, CPUE, and total catch figures for the five major inshore fishing methods during fiscal year 1978.

Fishing Method	Number of Persons	%	Number Person-Hours	%	Kg/P-H	Kg/G-H	Catch (Kg)	%
Hook and Line	2,016	30	6,548	31	0.21	0.20	1,387	14
Cast Net	1,046	16	2,507	12	0.57	0.67	1,421	14
Gill Net	2,045	31	6,685	31	0.46	1.14	3,063	30
Surround Net	808	12	3,795	18	1.00	6.67	3,574	35
Spearfishing	743	11	1,785	8	0.40	0.42	737	7
TOTAL	6,658	100	21,320	100	0.48	0.73	10,182	100

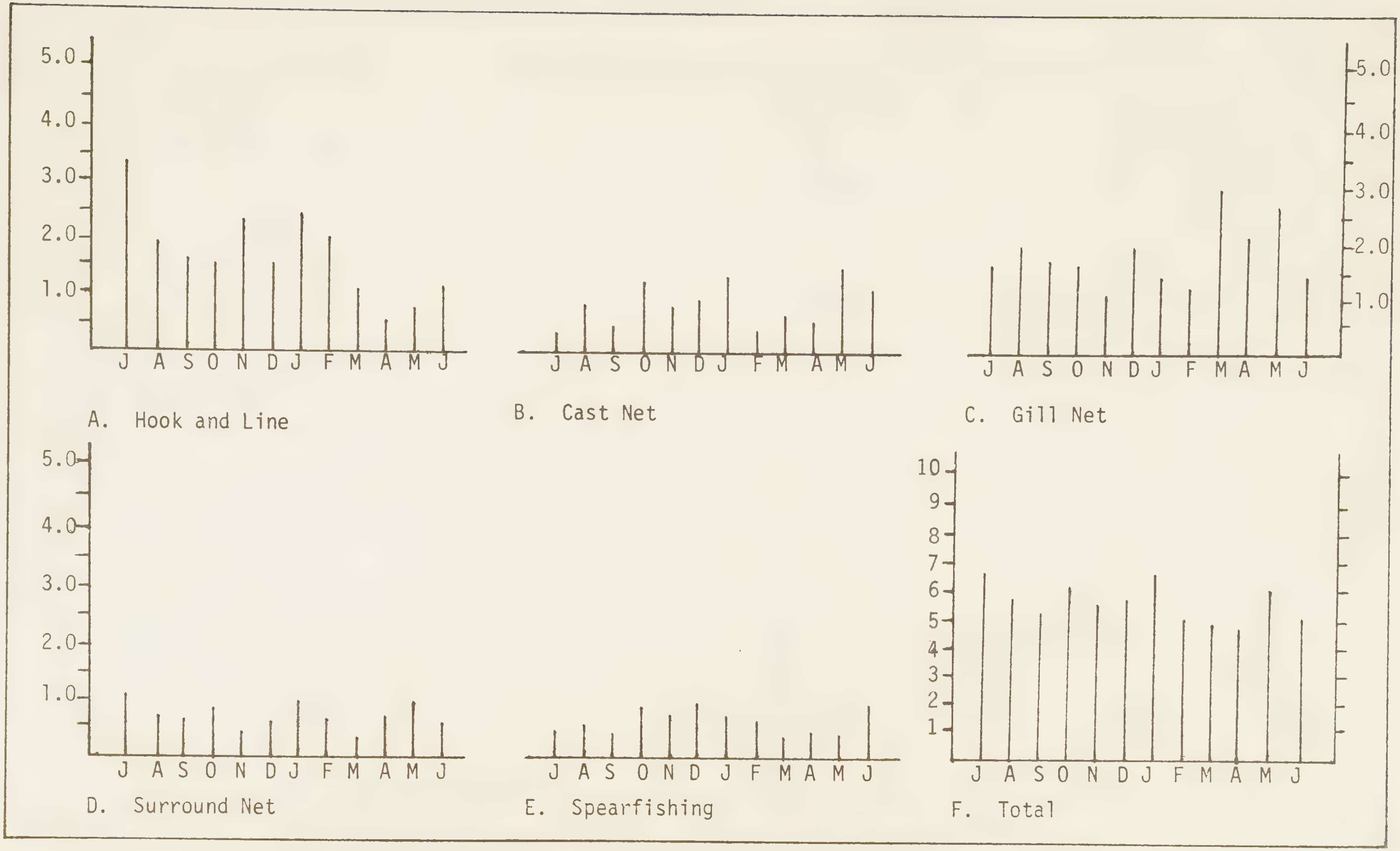


Figure 1. Monthly fishing participation in hundreds of persons by gear-type and overall for fiscal year 1978.

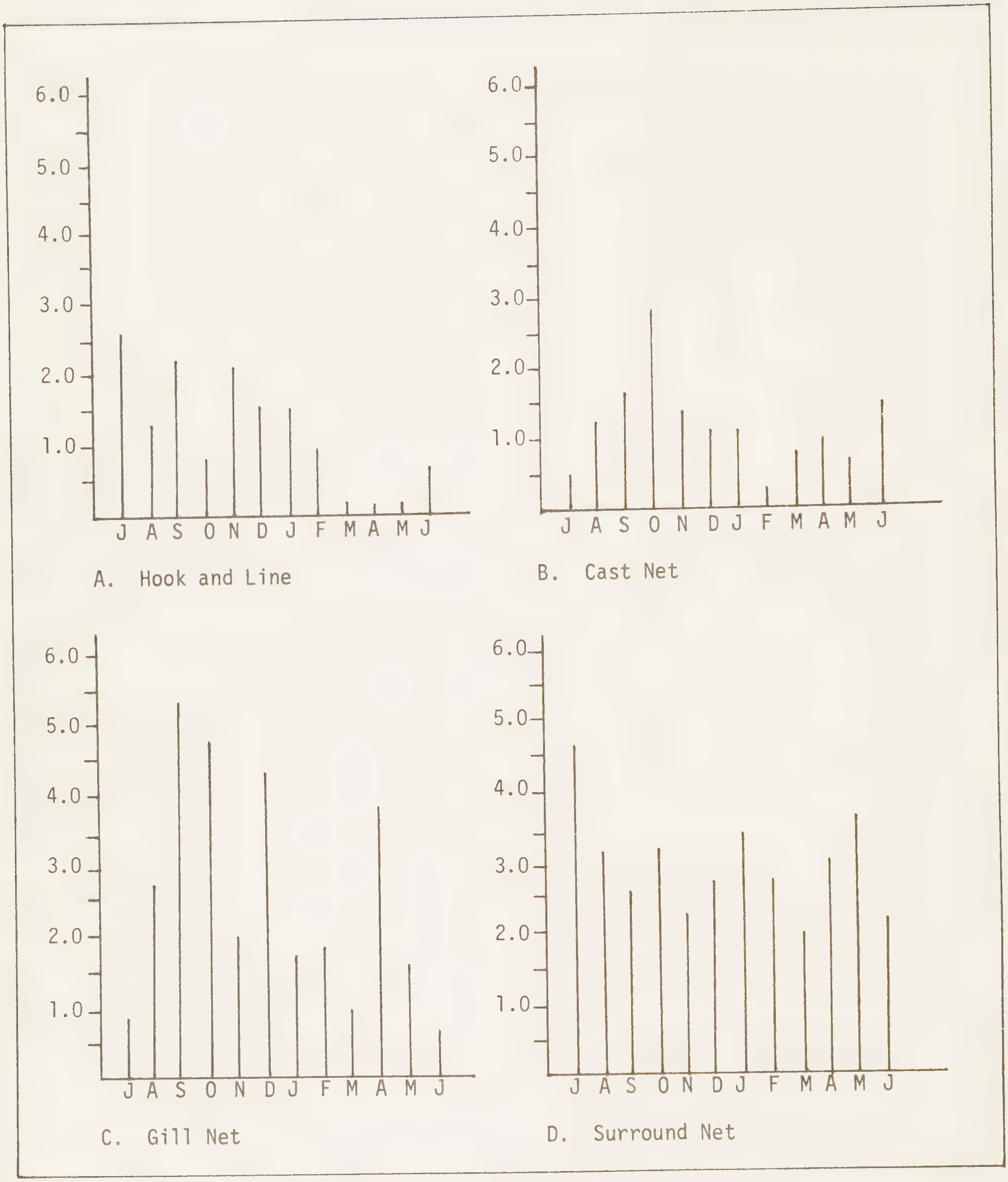
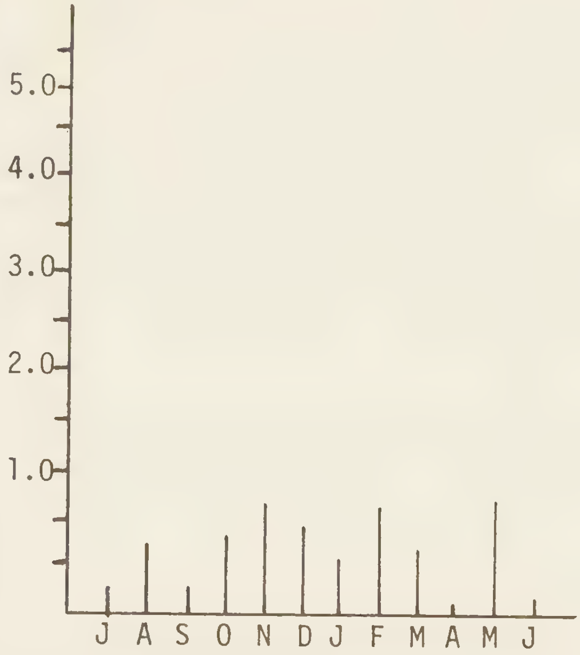
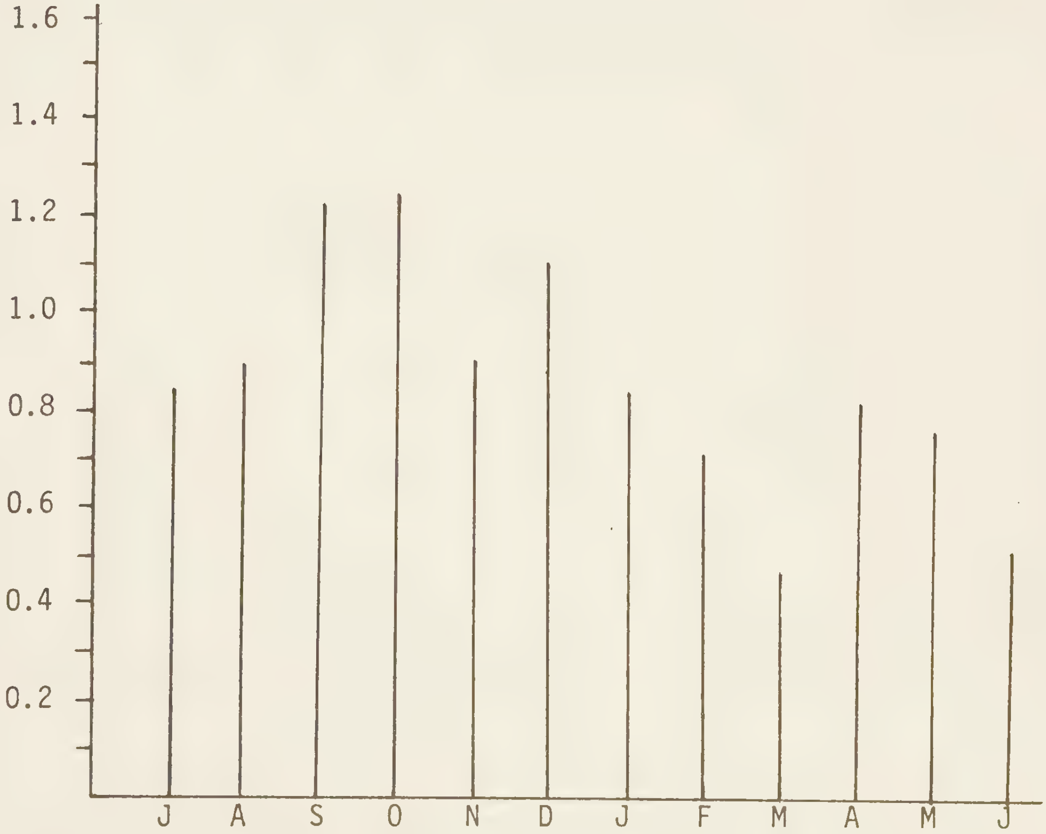


Figure 2. Monthly trends in catch in hundreds of Kilograms for the five major inshore fishing methods during fiscal year 1978.



E. Spearfishing



F. Total

Figure 2. (continued) The monthly catch for all methods combined (F. Total) is measured in metric tons.

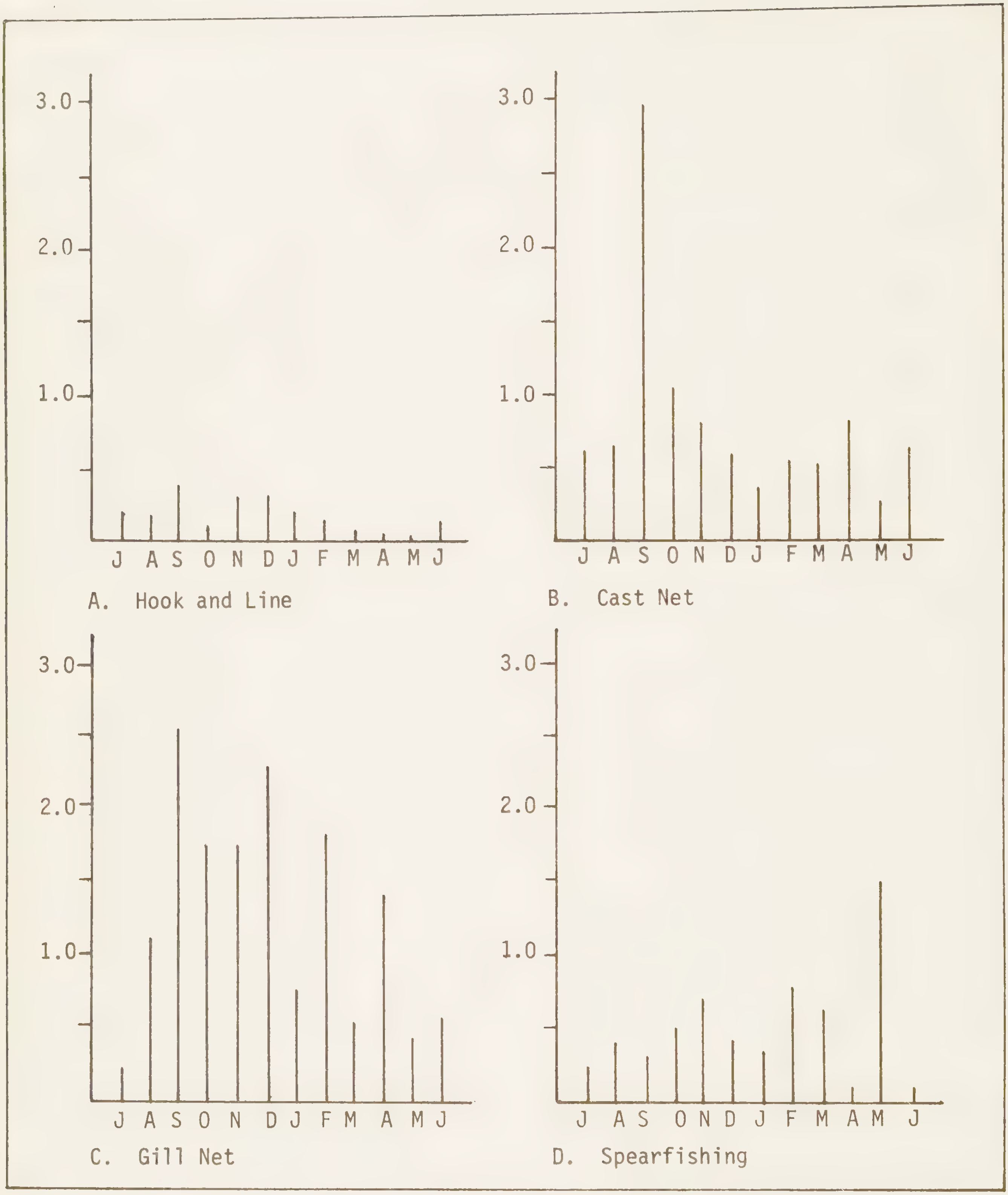


Figure 3. Catch per unit effort (CPUE) for four inshore fishing methods. CPUE is calculated as Kg/gear-hour.

F-1D Fish Weirs

During FY 79 eight fish weir sites were in operation on Guam. The operators of these fish weirs submitted 43 monthly catch reports which accounted for a total recorded fish catch of 3,133.4 Kg. This catch, broken down by major component species is presented in Table 1. By weight, most of this catch consisted of snappers (Lutjanidae, 20.8%), jacks (Carangidae, 18.9%), goat fishes (Mullidae, 14.8%), and soapys (Leiognathidae, 12.9%). An estimated annual harvest from all weir sites was calculated based upon this reported catch using the following formula:

$$\left[(Cr/Rm)\ 12\ (8)\right] - \left[(Cr/Rm)\ 12\ (8)\right] 0.1 = Ce$$

where Cr is the total reported catch in Kg; Rm is the number of monthly reports submitted by the weir operators during the year; 12 is the number of months in a year; 8 is the number of weir sites in operation; and, 0.1 is a correction factor for down time.

The result was a total estimated annual harvest of approximately 6,296 Kg of fish. Although this year's weir operators were more conscientious about submitting their monthly catch reports, there were still a significant number of reports missing from the analysis (59% missing). An accurate estimate of the annual fish weir harvest can only be based upon a fairly complete set of monthly catch reports. Therefore, it is again recommended that strict enforcement of the stipulations outlined in the fish weir permits regarding the monthly catch reports be continued. Failure to comply with these stipulations should result in the loss of the weir operator's current permit and the "retirement" of the weir site.

Report prepared by Michael E. Molina

Table 1. Fish weir reported and calculated harvest in kilograms by fish family for FY 79. The reported catch is from 43 monthly reports submitted by 6 weir operators for 7 weir sites.

Fish Family	Reported Catch (Kg)	Percent (%) of Total Catch	Calculated Harvest (Kg)
Acanthuridae (Surgeon Fishes)	84.8	2.7	170
Belonidae (Needle Fishes)	39.0	1.2	78
Carangidae (Jacks)	591.1	18.9	1,188
Leiognathidae (Soapys)	405.0	12.9	814
Lutjanidae (Snappers)	651.1	20.8	1,308
Mugilidae (Mullets)	209.6	6.7	421
Mullidae (Goat Fishes)	465.4	14.8	935
Serranidae (Groupers)	59.0	1.9	119
Scaridae (Parrot Fishes)	29.9	1.0	60
Siganidae (Rabbit Fishes)	220.7	7.0	443
Others	377.8	12.1	759
Total (12 mo.)	3,133.4	100.0	6,295
Expected Total (15 mo.)			8,745

F-1E Aerial Fishery Surveys

Twenty-four aerial surveys were scheduled between July 1978 and June 1979, but due to bad weather only 21 of these flights were completed. These included 11 weekday and 10 weekend surveys. Each flight began at approximately 1030 hours, and circled the island once just beyond the reef margin. The flights usually took about 1.5 hours to complete at an average altitude near 800 feet. The primary objective of this program was to obtain a more or less "instantaneous" evaluation of inshore fishing activity for the whole island. The surveys yielded data on fishermen participation, fishing methods employed, and locations used for fishing. Additional data was taken on offshore fishing activity, the numbers of porpoises, sharks and turtles observed in the near-shore surface waters just beyond the reef, and on coastal non-fishing activities. This data is presented in Table 1. The same 12 census regions employed in previous aerial survey programs were again used during FY 79. These regions are shown in Figure 1. Due to military restrictions on low flying aircraft, Region 5 (Apra Harbor) was not censused during this program.

A total of 858 persons were observed performing one or another of the inshore fishing methods. As last year, gill and surround netting was found to be the most popular method, attracting 44% of the observed inshore fishermen. Next in popularity were cast netting (25%) and hook and line fishing (22%). Comparisons were made between the aerial and inshore creel census participation data for the five major inshore methods. Inshore gill and surround net data were lumped to make the comparison valid. Our inshore surveys indicated the greatest participation (42%) in hook and line fishing. The reason for such widely separated estimates probably lies in the fact that our aerial surveys do not include Apra Harbor and are less accurate at the Agana Boat Basin during the atulai season. During this season hook and line participation increases at both locations, especially at the Agana Boat Basin. Also, the high degree of relief at the boat basin due to the presence of many tall trees, boat masts, light poles, large boulders, ect. results in aerial counts much less accurate than those made on the ground, particularly during the atulai season. However, overall, this year's inshore fishing activity appeared to have increased somewhat over that of FY 78. That is, the mean number of participants sighted per flight went up by about 10 individuals.

As usual, offshore near-island fishing activity was dominated by the method of multiple line surface trolling. Based on the aerial survey data, participation (number of boats) in this method appears to have changed very little since FY 78. This is misleading, however, since more accurate data derived from our offshore creel census program indicated a substantial increase in trolling participation this year. The method of bottom fishing seemed to drop in popularity during FY 79 and this is in agreement with the results of our offshore creel census analysis.

This year's total sightings of marine turtles, sharks and porpoises was fairly close in number to those of FY 78. However, the total number of porpoises observed near the island during FY 79 was down nearly 22%. There was a notable reduction in the number of sightings in Regions 1 and 2, with a significant increase in the number of Region 7 sightings. As usual, more porpoises were sighted in Region 11 than in any other (60%). Taken together, approximately 84% of the porpoises were counted in the latter two regions alone.

Total sightings of marine turtles increased about 57% over those of FY 78. Based on 82 aerial surveys conducted from FY 75, through FY 79, far more turtles have been sighted within Region 12 (Pati Pt. - Ritidian Pt.) than in any other (Fig. 2). A total of 285 turtle sightings were made within this area during that time (Table 2). This represents 36% of the five-year total of 783 individuals, and is almost as many turtles as were observed within Regions 8, 9, 10, and 11 (Cocos Lagoon - Pati Pt.) combined; that is 294 turtles or 37.5% of the five-year total. Taken together, approximately 74% of the observed turtles were seen within these five regions alone. The most probable explanations for this distribution are the relatively low levels of development and fishing pressure found in these areas.

Marine turtle abundance appears to peak twice during the year (Fig. 3). In general, these peaks occur during the winter/spring (December - June) months. This loosely correlates with Guam's "dry" tradewind season which usually persists throughout that time of year. It is unclear at the present time whether or not the turtles are mating during this entire period. The time of nesting is also unclear, however, reports from local fishermen indicate that nesting occurs around June.

Reports have been made of larger than usual numbers of turtles visiting Guam about every three years. The last of these visits occurred in 1976, and is reflected in our aerial survey data (Table 3). Another visit was expected this year, and again, our data shows the winter increase in numbers. However, this year's influx of turtles did not appear to be as strong as the one which occurred in 1976.

Since it is difficult to make positive species identifications on turtles from a moving airplane, we have no reliable estimate of the species composition of Guam's marine turtle community. However, it is generally regarded that the green turtle, *Chelonia mydas*, is by far the major component. This species has a known breeding cycle of about three years which would explain the tri-annual increase in numbers of turtles observed on the aerial surveys. This also supports information offered by a resident of Tarague Beach (west end) that turtle nesting at that site is heavier every third year or so. It may be that mating (and possibly nesting) occurs every year among the "resident" portion of Guam's turtle community, and that the tri-annual increase in numbers is due to the return of the "migrating" portion for mating and nesting, a behavior known to occur among *C. mydas* populations.

Report prepared by: Michael E. Molina

Table 1. Aerial Survey Data Collected on 21 flights during FY 79 (July 1978 - June 1979).

	REGIONS													
	1	4	3	4	5[1/]	6	7	8	9	10	11	12	Total	X̄/Flight
Inshore Fishing:														
Hook & Line	8	6	37	35		10	3	5	10	53	1	1	169	8.0
Cast Net	25	32	20	30		28	11	1	12	28	1	5	193	9.2
Gill & Surround Net	30	40	63	99		33	2	11	29	39	0	1	347	16.5
Spear (Scuba)	2	0	1	0		2	0	2	0	0	0	0	7	0.3
(Snorkel)	9	5	6	27		11	5	4	0	0	0	0	67	3.2
Octopus Hunting	0	0	0	4		4	0	0	5	17	0	0	30	1.4
Clamming	0	0	4	18		0	0	4	0	0	0	0	26	1.2
Weir Tending	0	0	0	0		0	0	17	0	2	0	0	19	0.9
Sub-Total (persons)	74	83	131	213		88	21	44	56	139	2	7	858	40.8
Offshore Fishing:														
Trolling Boats	65	5	7	4		1	8	17	0	1	2	4	114	5.4
Bottom Fishing Boats	3	0	0	2		2	3	3	0	0	1	1	15	0.7
Dive Boats	17	3	2	6		23	4	10	1	0	0	0	66	3.1
Divers (Scuba)	28	21	6	20		66	13	7	3	2	0	0	166	7.9
(Snorkel)	12	10	2	6		12	6	12	0	2	0	0	62	2.9
Sub-Total (persons)	40	31	8	26		78	19	19	3	4	0	0	228	10.9
(Boats)	85	8	9	12		26	15	30	1	1	3	5	195	9.3

[1/] Area 5 encompasses Apra Harbor, and is presently not overflown due to military security restrictions.

Table 1. (continued)

	REGIONS													
	1	2	3	4	5	6	7	8	9	10	11	12	Total	$\overline{X}$/Flight
Non-Fishing:														
Surfers	0	3	67	41		5	0	7	0	64	0	0	187	8.9
Picnickers	374	1324	435	117		341	49	949	53	400	0	497	4539	216.1
Other Persons	17	8	7	13		32	20	31	4	19	1	13	165	7.9
Other Boats	5	2	2	7		15	6	55	1	0	0	0	93	4.4
Sub-Total (persons)	391	1335	509	171		378	69	987	57	483	1	510	4891	232.9
(boats)	5	2	2	7		15	6	55	1	0	0	0	93	4.4
Total (persons)	505	1449	648	410		544	109	1050	116	626	3	517	5977	284.6
(boats)	90	10	11	19		41	21	85	2	1	3	5	258	13.7
Marine Life:														
Porpoise	0	0	0	0		0	105	0	0	0	270	76	451	21.5
Sharks	1	0	2	0		0	1	3	6	14	7	1	35	1.7
Turtles	4	1	1	1		1	6	1	45	34	16	84	194	9.2
Total	5	1	3	1		1	112	4	51	48	293	161	680	32.4

Table 2. Summary Of Turtle Sightings By Aerial Survey Region For Fiscal Years 1975 Through 1979

	REGION													
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	NUMBER MONTHS
FY'79	4	1	1	1		1	6	2	43	31	18	77	185	12
FY'78	6	3	1	9		6	14	3	10	1	15	15	83	12
FY'77	0	3	1	1		4	1	5	10	0	8	8	41	2
FY'76	7	5	6	6		35	8	14	44	10	12	42	189	9
FY'75	14	5	18	3		23	11	9	37	16	6	143	285	6
TOTAL	31	17	27	20		69	40	33	144	58	59	285	783	41
$\overline{X}$/REGION	6	4	6	4		15	8	8	31	12	13	59		

Table 3. Summary Of Turtle Sightings By Month For Fiscal Years 1975 Through 1979

	MONTH													
	J	A	S	O	N	D	J	F	M	A	M	J	TOTAL	NUMBER FLIGHTS
FY'79	12	3		6	7	12	18	52	24	14	20	11	185	24
FY'78	7	6	10	4	16	17	7	5	0	3	4	4	83	24
FY'77	23			18									41	4
FY'76		20	28	24	20	42	16	10	7	22			189	18
FY'75							45	44	32	46	54	64	285	12
TOTAL	42	29	44	52	43	71	86	111	63	85	78	79	783	82
$\overline{X}$/MONTH	14	12	15	13	14	24	22	28	16	21	26	26		

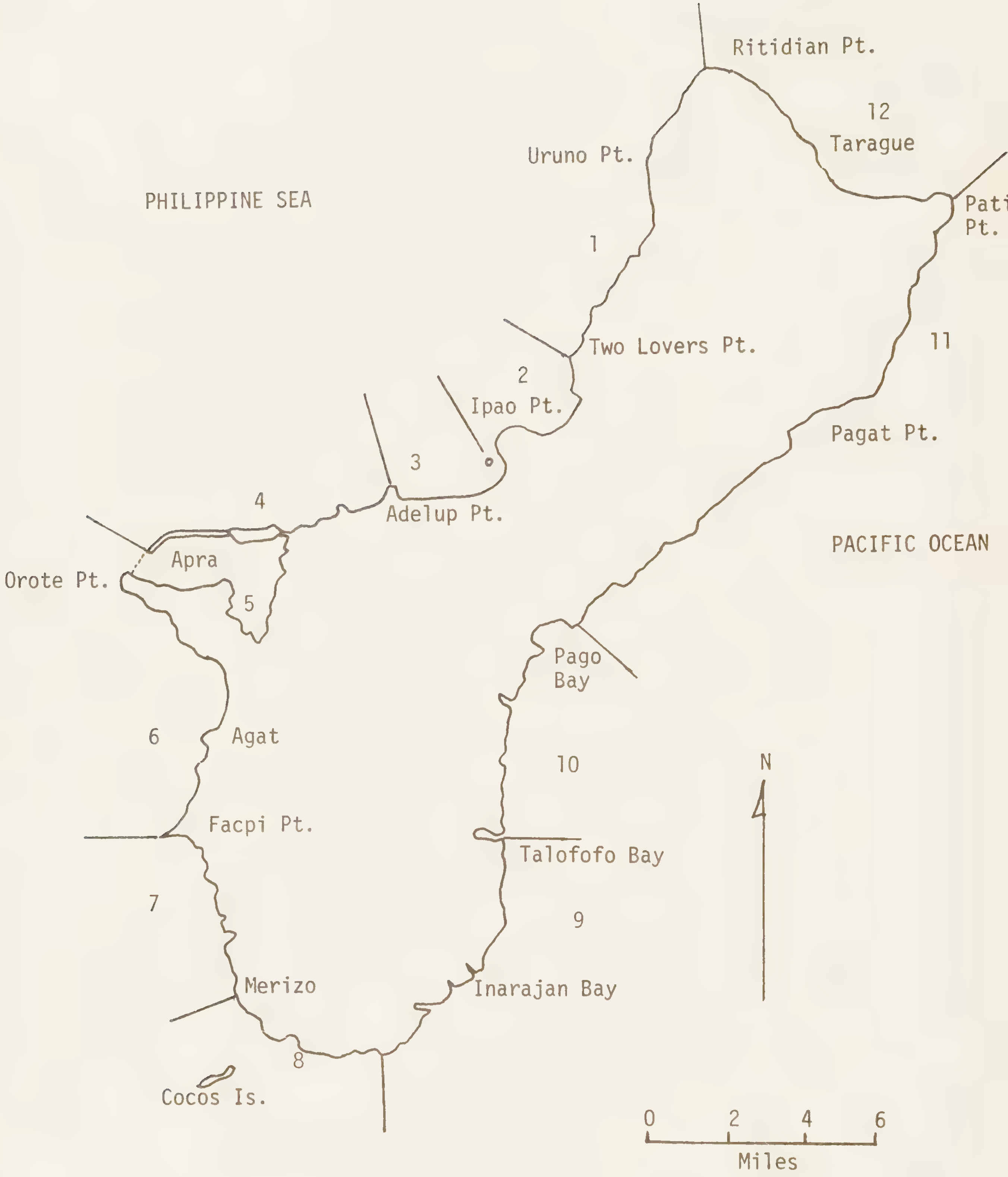

Ritidian Pt.
12
Taraque
Uruno Pt.
PHILIPPINE SEA
Pati
Pt.
1
Two Lovers Pt.
11
2
Ipao Pt.
Pagat Pt.
3
4
Adelup Pt.
PACIFIC OCEAN
Apra
Orote Pt.
5
Pago
Bay
6
Agat
10
N
Facpi Pt.
Talofofo Bay
7
9
Merizo
Inarajan Bay
8
Cocos Is.
0
2
4
6
Miles

Figure 1. The island of Guam with its twelve aerial survey regions.

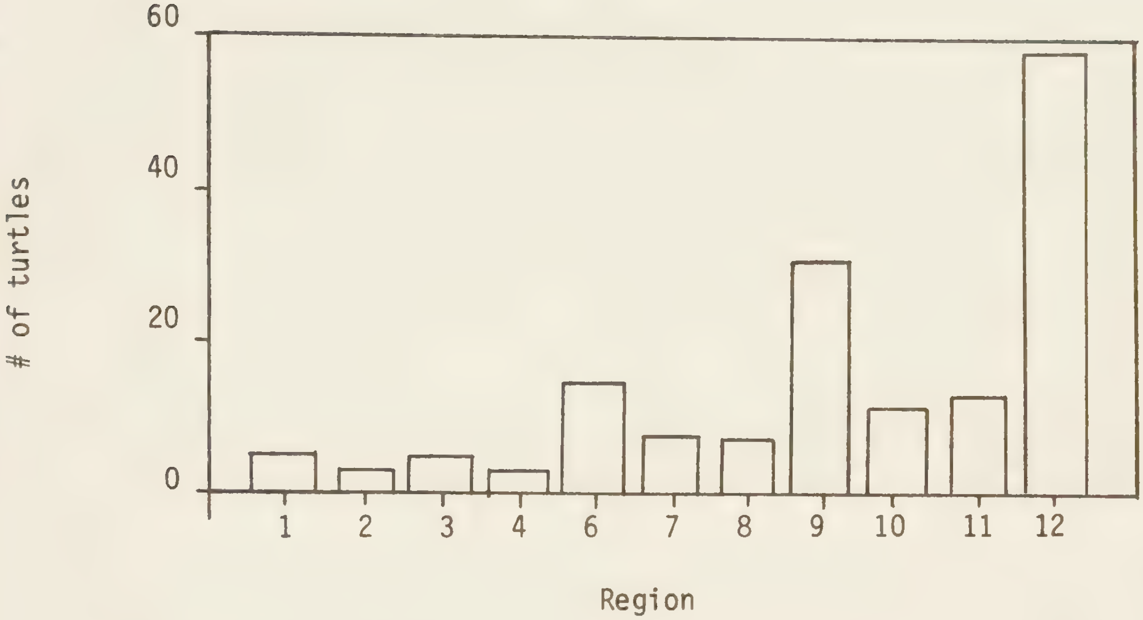


Figure 2. Mean number of turtles observed annually in the survey regions during Fiscal Years '75 -'79.

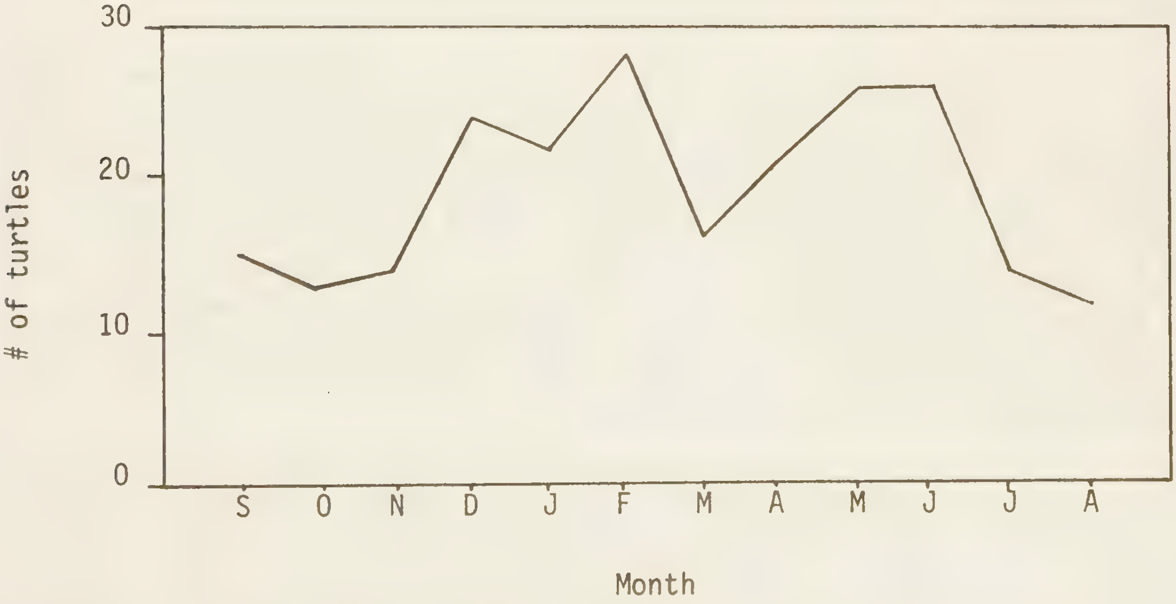


Figure 3. Mean number of turtles observed per month during Fiscal Years '75 -'79.

F-1F Reef-Fish Population Study

This part of job F-1 has been neglected for sometime in favor of upgrading our creel census and data analysis programs. However, this year major steps were taken to re-design and re-initiate this project as part of our DJ Investigations. The objective of this study has been shifted from one of obtaining reef-fish biomass estimates to one of examining the variability associated with reef-fish populations on coral reefs. More specifically, this project is designed to help identify possible sources of variability and to quantify the extent to which these variables may affect the species composition, abundance, and/or distribution of certain reef-fishes within localized areas. The variables which will be most closely examined include the following: depth, location (of study area), substrate and time.

In order to monitor the effects of these variables on Guam's reef-fishes permanent transects have been established off of Asan Point and Ipao Point on the leeward (western) shore of Guam (Figure 1). A U. S. Army Corps of Engineers Permit has been granted to us for this purpose (Fig. 2).

At each site replicate 50 meter transects are located along depth contours of 15, 30, 60 and 100 feet (4.6, 9.1, 18.3 and 30.5 meters, respectively). A transect consists of six unconnected rebar stakes, each one 12-18 inches (30.5-45.7 centimeters) in length, embedded into reef rock at 10-meter intervals. Fishes in each 10-meter section are currently being sampled by direct visual censusing through the use of SCUBA. All of the underwater data is recorded on a micro-cassette tape deck which is carried in a waterproof housing by the biologist. The use of this tool should greatly reduce the observer-error involved in accurately sighting and recording all fishes present. Certain bits of topside data including further remarks concerning the transects or fish activities, such as the existence and locations of the largest feeding aggregations or unusual species sighted are recorded on special field log sheets (Fig. 3).

Counts of individuals are made for fish species observed within a vertical 2 m^2 area centered on and running from stake to stake on each transect. Fish counts on the transects are made only between the hours of 1000 and 1400 on field days. Dives are limited to two depths per day, normally grouped as 100 and 15 feet; and, 60 and 30 feet. On any one day both 50 meter transects at each of the two depths are censused twice. Usually four to six field days per month are required to maintain the transects and to do the fish counts. We plan to monitor the transects for a full seasonal cycle which may not necessarily take 12 months to complete. Thus, the projected length of time needed for the required field work has been set at 12-14 months. Data collection began in August of this year.

For the purpose of evaluating the effects of substrate, each 10-meter section of transect will be ranked in terms of its relief and/or porosity by fitting each to a matrix based on field measurements of vertical relief and subjective evaluations of porosity (Fig. 4). Vertical relief for any 10-meter section may be characterized by using the 10 largest measurements obtained within that section. Porosity is much more difficult, if not impossible, to measure directly. Therefore, it will be estimated subjectively based upon the numbers and sizes of holes present within the sections. The fish faunas of sections with similar relief/porosity estimates may then be compared.

As part of the analysis the variable of time will be sub-divided into the following: "instantaneous", lunar/monthly, seasonal (rainy/dry), and within month variability due to weather differences. An estimate of "instantaneous" variability (and "diver effect") may be derived from replicate transect counts made on the same dive. To analyze the effects of within month weather differences between the two study areas, similar 10-meter transect sections may be lumped. Lumping will be done after the fish faunas of the relavent sections have been shown to be statistically comparable.

Wind, rainfall and sea swell data are currently being provided to us by the weather office at the U. S. Naval Air Station, Guam, and they have agreed to do so until the completion of this project. Since the weather conditions preceeding a census day may significantly influence the results of that day's fish counts, particular importance is placed on weather data taken during the three days prior to the census day. Throughout the statistical analysis the null hypothesis will be that there is no significant difference between sets of data for each variable that is tested.

Report prepared by Michael E. Molina

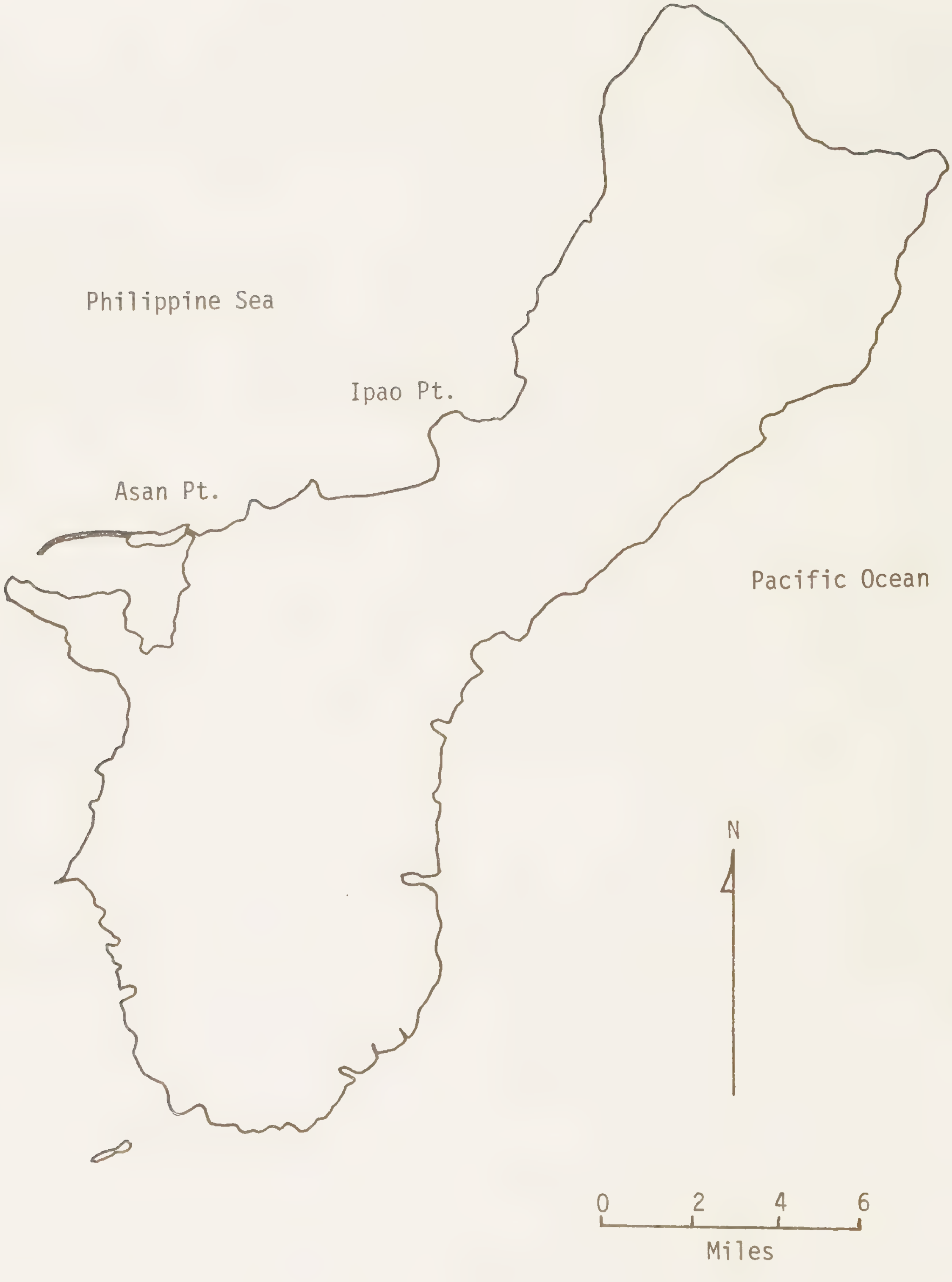
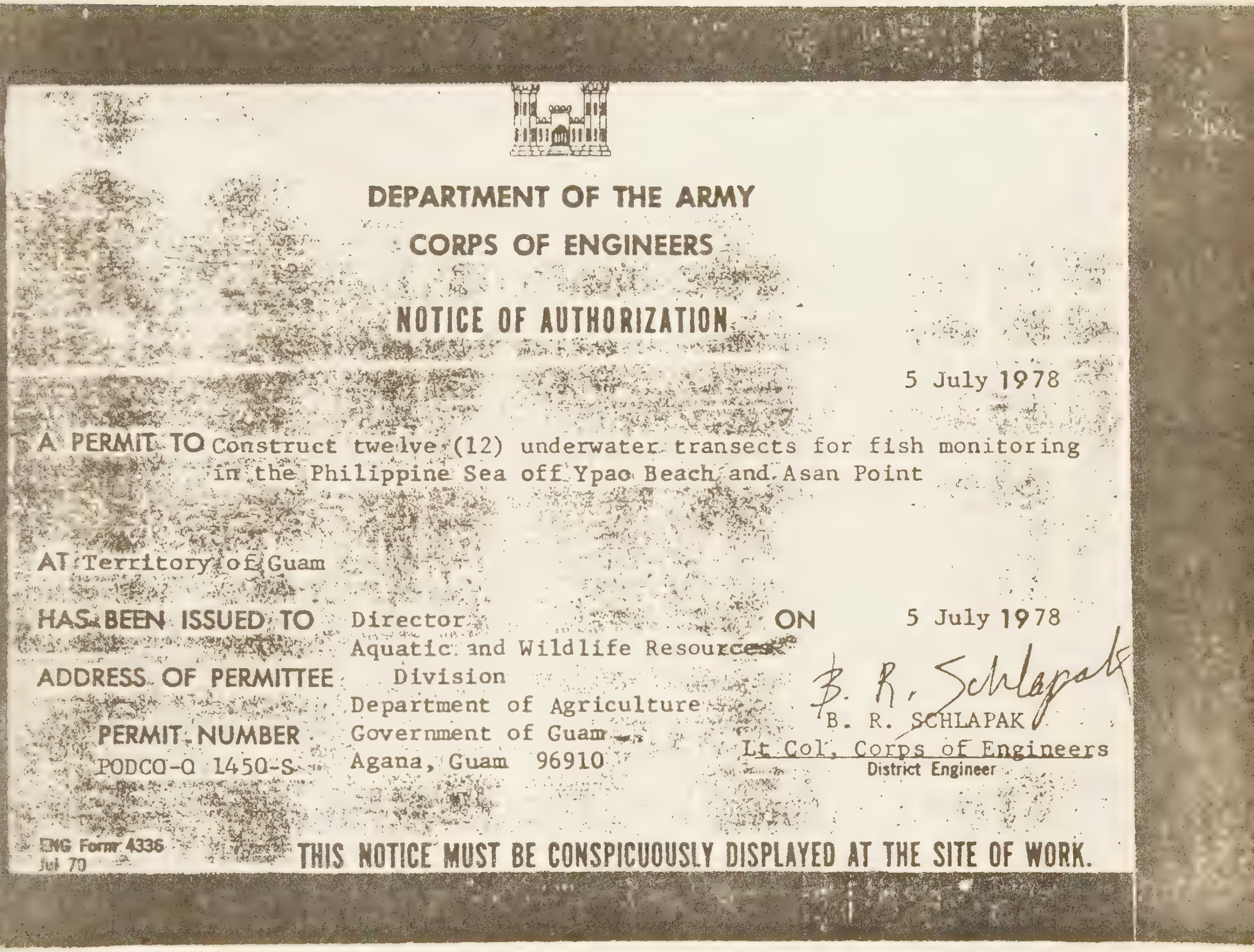

Philippine Sea
Ipao Pt.
Asan Pt.
Pacific Ocean
N
0
2
4
6
Miles

Figure 1. Map of Guam showing the locations of the study sites.



DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

NOTICE OF AUTHORIZATION

5 July 1978

A PERMIT TO Construct twelve (12) underwater transects for fish monitoring in the Philippine Sea off Ypao Beach and Asan Point

AT Territory of Guam

HAS BEEN ISSUED TO Director ON 5 July 1978

ADDRESS OF PERMITTEE
Aquatic and Wildlife Resources
Division
Department of Agriculture
Government of Guam
Agana, Guam 96910

PERMIT NUMBER
PODCO-O 1450-S

B. R. Schlapak
B. R. SCHLAPAK
Lt Col, Corps of Engineers
District Engineer

ENG Form 4336
Jul 70

THIS NOTICE MUST BE CONSPICUOUSLY DISPLAYED AT THE SITE OF WORK.

Figure 2. U.S. Army Corps of Engineers Permit granting permission to construct the permanent reef transects used in this study.

Reef-fish Population Study
Aquatic and Wildlife Resources - Dept. of Agriculture

Study Site____________________ Transects_______________ Date_________________

Dive Partner__________________ Remarks:

Weather_______________________

% Cloud Cover_________________

Sea State_____________________

Wind__________________________

Swell_________________________

Reef-fish Population Study
Aquatic and Wildlife Resources - Dept. of Agriculture

Study Site____________________ Transects_______________ Date_________________

Dive Partner__________________ Remarks:

Weather_______________________

% Cloud Cover_________________

Sea State_____________________

Wind__________________________

Swell_________________________

Figure 3. Dive Log and Field Data Sheet

VERTICAL RELIEF
(cm)

POROSITY

	NONE	low 0-30.5	moderate 30.5-61.0	high 61.0-122.0	extreme > 122.0
NONE					
LOW					
MODERATE					
HIGH					
EXTREME					

Figure 4. Substrate ranking matrix based on field measurements of vertical relief, and subjective porosity estimates based on the numbers and sizes of holes. Each 10-meter section of transect may be assigned to an appropriate box within the matrix.

F-1G Compilation of a checklist of the food and game fishes of Guam

BACKGROUND:

The task of inventorying the fishes of Guam was initiated in 1963. Since then, a checklist and two supplemental checklists of fishes collected or recorded from Guam were published in Micronesica, a journal of the University of Guam.

The first checklist was published in 1968 listing 465 species, representing 80 families. The supplement to this checklist listing an additional 133 species representing 45 families was published in 1971. A second supplement published in 1975 lists an additional 75 species and four families of fishes previously not recorded from Guam.

These three publications list a total of 673 species and 94 families of fishes collected or recorded from Guam. These figures are considerably larger than the figures reported in the Annual Progress Reports. This discrepancy exists because the figures presented in the Progress Reports represent only those species with representative specimens in the reference collection at the University of Guam. The figures of the published checklist and the supplements also include species listed in various publications but not necessarily represented by specimens in the reference collection.

The fishes listed in the checklist and its supplement were incorporated into a computerized taxonomic listing of the Hawaii Coastal Zone Data Bank (HCZDB). The HCZDB is a computerized system to assign identification code numbers to organisms of the Pacific Basin for storage and retrieval.

OBJECTIVES:

To compile a checklist of all the food and game fishes found in Guam waters, listing the scientific, common, and local names for each species.

PROCEDURES:

I. Food and game fishes are collected by means of traps, hook and lines, spearing, poisoning and nets throughout the period.

II. Field examinations of fish caught by various sportsmen are also conducted.

III. Literature surveys are made to determine scientific, common and Guamanian names.

IV. The collected fish are preserved, identified, and deposited at the University of Guam.

FINDINGS:

This project was inactive during this report period.

RECOMMENDATIONS:

It is recommended that this project be continued.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

TERRITORY: Guam

PROJECT NO.: FW-2R-16

JOB NO.: F-4

PROJECT TITLE: Guam Fish and Wildlife Investigations

JOB TITLE: Habitat Improvement of Inshore Lagoons

OBJECTIVES:

1. Evaluate the use of steel ships as artificial reefs which increase the available fish habitat in an area and ultimately the number of fish available to fishermen.
2. Estimate the impact of a steel ship artificial reef on the surrounding fish community.
3. Determine the recruitment patterns of fishes to the artificial reef.
4. Predict what the impact of a much larger steel ship would be.
5. Identify what factors should be considered in future projects.
6. Investigate and develop methods for fish aggregation.

BACKGROUND:

Originally two pilot artificial reefs of different designs were constructed in Cocos Lagoon with discarded tires. The first reef, AR-A, constructed during FY 70 was built of tires grouped into triads of 15 tires each and scattered in an area 25m x 25m. A total of 351 tires were placed in the area. During FY 71, 72 and 73 a second artificial reef, AR-B, was constructed from 2,482 tires, about 100 meters east of the first reef. This reef was built with tires lashed together to form tubes of 5 tires each. These "tubes" were randomly placed to form a heap about 5 m high with a base approximately 8m x 16m.

Fish counts on the artificial reefs showed that the species diversity and total numbers of fish were always higher at the "heap" reef, AR-B, than at the low profile "triad" reef, AR-A. Neither reef attracted significant numbers of large fishes but there usually were many juvenile fishes associated with the "heap" reef. Coral recruitment and growth was poor on the tire reefs due to heavy siltation in Cocos Lagoon; the major species to colonize the tires has been *Pocillopora damicornis*.

A third artificial reef was constructed during FY 78 in Agat Bay, ARAB-I. This reef was made from a 16.7 m Navy LCM barge which was modified so that the barge pan was roofed by large diameter (0.2 m) pipes. Fish counts were made bimonthly on the artificial reef and four transects near it. The barge attracted resident fish at a rate of approximately 17 fish per month during the first 9 months of the study. The strongest increases were in the numbers of planktivores above the barge, nocturnal carnivores residing under the barge, and grazing herbivores along the sides of the barge. The most important change in the fish community was an increase in the numbers of larger (>0.5 kg) fishes visiting the artificial reef. These fishes included serranids and lutjanids that were not seen in the area before the barge was sunk and which usually are found beyond the 40 m drop off. A few acanthurids, scarids, and pomacentrids used the artificial reef for refuge at night.

In contrast to the structure of the artificial reef fish community in which carnivores dominated with 40% of the population, the natural reef community counted on the transects was dominated with 40% herbivores. Herbivores comprised the same porportion as they did in the environmental assessment before the barge even though fish densities also increased on the transects during the first nine months of the study. These fish density increases on the transects were suspected to be a seasonal phenomena unrelated to the artificial reef.

METHODS:

The effects of ARAB-I on the fish community were assessed between October 1977 and May 1979 by means of fish counts on the barge, on transects nearby, and on transects some distance away. The fish counts on the barge consisted of enumerating the number of fish by species in each of four quadrants, fore and aft, both above and below the structure. The reef transects were delineated using nylon line stretched between cement nails embedded in the coral pavement. Each line was divided into three meter intervals with knots to facilitate counting small territorial species accurately. A fish count on the transects consisted of enumerating the number of fish of each species observed between two successive knots and within one meter to either side of the transect line. Transient fish species within two intervals ahead of the one being counted, were enumerated and recorded for their appropriate interval.

Seven transects were used and arranged in three groups (Figure 1). Transects A and B were 21 m long and ran perpendicularly away from the artificial reef, C and D were 24 m long and were oriented parallel to the artificial reef at some distance away, and E, F and G were each 24 m long and served as controls nearly 50 m away. Fish counts on the barge and transects were made between 1030 and 1400 hours twice a month when practical within the decompression limits of scuba diving and available boat time. Transects A and B were counted most regularly (Table 1) and served as the basis of most of the statistical computations presented here.

In most cases, data collected from the fish counts are standardized to give the numbers of individuals per 100 m^2. The four areas used for the barge and transect groups A-B, C-D, and E-F-G are 68 m^2, 84 m^2, 96 m^2 and

138 m^2 respectively. The numbers of large fishes are not standardized per unit area, but are presented in absolute numbers.

Statistical analysis in this study used the density values from each individual count, and not monthly averages. Graphs were constructed from individual counts in some cases and monthly averages in others.

The distribution patterns of certain seasonally recruiting fish species were examined over a 249 m linear transect. The transect was divided into 83 contiguous 3 x 2 m "census quadrats". The topographic features of each patch were largely described, and the numbers of adult and juvenile fishes were counted for the two most abundant species. Only one count was made on 30 March 1979.

RESULTS & DISCUSSION:

I. Variations in Fish Abundance

All 120 species of fishes encountered in this study (Table 2) exhibited one of three basic patterns of density changes that contributed to the overall density changes observed on the artificial reef and transects Table 3. The densities of most species varied irregularly within a few percent of their overall mean as a result of the unpredictable comings and goings of individuals over the census areas. Populations of certain other fishes, which all occurred on the barge, exhibited net increases in abundance as a result of accumulations. The population densities of the few remaining species increased and decreased in a nonrandom cyclic manner. The combined results of these patterns amounted to a steady increase in numbers of fishes on the artificial reef and a distinct cyclical-seasonal variation in the abundance of fishes on the transects (Figure 2).

Nonregular Variations

A majority of the species, including all the acanthurids, balistids, scarids, chaetodontids and most of the mullids and labrids exhibited apparently random variations in their densities during the 20 months of this study. Some of this variability was a result of variations in visibility among census periods but apparently most of the variability was a result of the unpredictable comings and goings of individuals over the census areas. Randomly varying species on the transects included acanthurids (*Acanthurus nigrofuscus*, *Ctenochaetus striatus* and *Naso litteratus*), balistids (*Melichthys vidua* and *Sufflamen bursa*), scarids (*Scarus chlorodon*, *S. sordidus* and *S. venosus*) and other species including *Chaetodon punctatofasciatus*, *Canthigaster solandri*, *Cirrhitichthys falco*, *Ptereleotris evides*, *Thalassoma lutscens*, *Parapercis clathrata*, *Parupeneus trifasciatus*, and *Centropyge heraldi*.

The major randomly varying species on the artifical reef included the above mentioned scarids and acanthurids, plus *Chaetodon auriga*, *Forcipiger flavissimus*, *Heniochus chrysostomus*, *Adioryx spinifer*, *Halichoeres centiquadrus*, *Monotaxis grandoculis*, *Macolor niger*, *Parupeneus trifasciatus*, *Parupeneus bifasciatus*, *Epinephelus fasciatus*, *Zanclus cornutus*, *Canthigaster solandri* and *Thalassoma lutescens*. Among these species, the scarids, acanthurids, labrids and mullids were using the barge primarily as a feeding substratum either for filamentous algae, sediment "dust", or micro-invertebrates. The rest of the species were apparently using the barge primarily for daytime refuge.

Accumulations

Some fishes which occurred only on the artificial reef exhibited steady increases in their densities. The strongest increases were in the numbers of nocturnal fishes which used the artificial reef for daytime habitat. These were *Adioryx caudimacula*, *A. ruber*, and *Myripristis murdjan* (Figure 3, F). The planktivores *Dascyllus trimaculatus* and *Chromis xanthura* (Figure 3, E) exhibited the greatest increases on top of the barge. These species which used the barge's vertical relief to enable themselves to feed higher in the water column also used the barge at night for habitat. Of particular interest was one adult *Plectorhynchus orientalis* which was seen in or under the barge on every count since November 1978. Because it would be so easy to spear this fish, its continued existence suggested that there was little human interference with the development of the artificial reef fish community in the last year.

Seasonal Variations

Sixteen fish species exhibited clear cut cyclical variations in their abundances during the study period. Four particularly abundant species accounted for nearly all the bimodal seasonal variation in fish abundance shown in Figure 2. In the order of relative abundance they were *Glyphidodontops traceyi*, *Pomacentrus vaiuli*, *Cirrhilabrus* sp. and *Halichoeres biocellatus* (Figure 4). Less abundant seasonal species found on the transects included *Meiacanthus atrodorsalis*, *Pomacentrus lacrymatus* and *Cheilinus rhodochrous*. Seasonal species found on the artificial reef were *Chromis acares*, *C. agilis*, *C. xanthura*, juvenile *Cheilodipterus macrodon*, apogonid species 1 and 2, *Mulliodicthhys flavolineatus*, *Synodus variegatus* and *Aulostomus chinensis*. *G. traceyi* and *M. atrodorsalis* were seasonal on the artificial reef as well as on the transects.

The seasonal increases observed among the various fish species were caused by either an immigration of adults, an immigration of older juveniles, or an increased number of juveniles settling directly out of the water column on the the census areas. Increases of *C. rhodochrous*, *S. variegatus* and *A. chinensis* (Figure 5) were a result of the greater numbers of their adults on the census areas at certain times of the year. The percentage of all fish counts in which more than three individuals were counted was significantly greater for each species ($P<.001$) for the months of April through July than during all the other months of the year (Table 4). Of special interest, because these three species are partially piscivorous, was the parallel occurrence of other large piscivorous species on the artificial reef only during March, April and May. These individuals each weighed more than 0.5 kg, and in some cases exceeded 6 kgs, including unusually large specimens of *Parupeneus chrysostomus*, *Adioryx spinifer*, *Lutjanus monostigma*, *Epinephelus tauvina*, and *Lutjanus bohar*). The *E. tauvina* was easily identified by its torn caudal fin and was counted on all but two surveys from March to May 1978. The *L. bohar* also had a charateristic torn fin and was counted on all five surveys during April and May 1979. Large individuals of these species are usually seen only beyond the -46 m drop off near the study area.

The variability of five other seasonal species was a result of the immigration of older juveniles that had first settled out from the water column elsewhere (Figure 3F-K). Their highest densities occurred sometime after May. Those species that recruited as younger juveniles did so earlier in the year than those that recruited as young adults. The three apogonid species, for example, immigrated to the artificial reef as juveniles in May, while young adults of *M. flavolineatus* immigrated in July.

The remaining eight seasonal species exhibited increases as a result of their juveniles settling out of the water column on the census areas at nearly the same time between February and March. Of these species, which also include *C. acares*, *C. agilis*, *C. xanthura* (Figure 3, A,D,E), *H. biocellatus* *P. lacrymatus* and *Cirrhilabrus* sp., *P. vaiuli* and *G. traceyi* were the most abundant.

II. Spatial Patterns in Recruitment

Factors affecting the recruitment distribution of juvenile *P. vaiuli* and *G. traceyi* were determined from a single fish count made on eighty-three 3m x 2m contiguous "census quadrats" along a 249 meter transect established on the -18.5 m depth contour. It was apparent that along this transect the juveniles exhibited clear-cut preferences for certain substrata. Preferred substrata for both species were those that provided rock, coral or algal overhangs characteristic of reef depressions (.5 m to 2 mep and .5 m or more in diameter) and sand channel walls (1.5 m to 3 m high). In contrast to the high recruitment to these substrata, live and dead hard coral substrata with no relief, depressions or porosity were very poor in recruitment. Similar substratum preferences were apparent for juvenile *H. biocellatus* and *Cirrhilabrus* sp.

The distribution of juvenile *P. vaiuli* and *G. traceyi* was nonrandom over the 249 meter long transect because they were usually found associated with particular types of substratum features and because the substratum composition on the transect varied from one end to the other. Coefficient of dispersion values showed that the distributions of juveniles of these two species were significantly clumped ($P<.001$, Table 5) even when adjacent linear reef areas, as large as 90 m^2 (2m x 45m, or 15 contiguous census quadrats) were compared. This supports the conclusion that there were areas along the transect where juveniles of both species were abundant and other adjacent areas where juveniles of both species were scarce because of differences in reef structure. The coefficient of dispersion values calculated for adult *P. vaiuli* and *G. traceyi* were not significantly different from 1.0, which indicates that adults were distributed randomly. Since adult densities represent the surviving individuals from previous recruitment periods, it appears that the distribution of these two species over large areas of reef changes from a clumped distribution in spring (as a result of selective juvenile settlement) to a random one later (as juveniles mature and most disappear). Twenty months of observation on transects A through G suggest this pattern may also be characteristic of *H. biocellatus* and *Cirrhilabrus* sp.

III. Possible Causes of Seasonal Decreases

There were only a few obvious causes for the population declines of the seasonal species in this study. The first was the change in life style that occurred as juveniles of certain species matured. Juvenile *C. xanthura* metamorphose after about four months and, instead of being associated with the barge surfaces, adults spend their time several meters above the barge or over the reef feeding on plankton. This caused them to be more spread out and left fewer individuals on the artificial reef. A similar situation existed with *Cirrhilabrus* sp. and *H. biocellatus*. Juveniles of these species maintained small home ranges and were easily and accurately counted for their first four months; then they developed adult behavioral patterns. In contrast to juveniles, adult *Cirrhilabrus* sp. formed roving schools while adult *H. biocellatus* roamed over large reef areas as individuals. As a result of these changes, the appearance of individuals became irregular and densities on the transects declined. Although life style *C. xanthura*, *Cirrhilabrus* sp. and *H. biocellatus* occurred before they matured.

The major density declines of *H. biocellatus*, *Cirrhilabrus* sp. and juvenile *C. xanthura* occurred between April and June, the same time as the major density declines of *P. vaiuli*, *G. traceyi*, *C. agilis* and *P. lacrymatus*. Also during this time period, the highest density records for *C. rhodochrous*, *S. variegatus* and *A. chinensis*, and the only records of large predators (e.g. *L. bohar* and *E. tauvina*) were obtained. This suggests a possible predator-prey relationship.

The possibility of such a relationship existing between the forage fishes, *P. vaiuli*, *G. traceyi*, *H. biocellatus*, and *Cirrhilabrus* sp., and the predator fishes *C. rhodochrous*, *A. chinensis* and *S. variegatus* is particularly apparent in their parallel variation over time in Figure 5. *C. rhodochrous*, *S. variegatus* and *A. chinensis* were observed during fish counts to strike at and catch small fishes. The gut contents of four out of six *C. rhodochrous* speared after a midday fish count included fish material as well as microcrustaceans; one *C. rhodochrous* (16 cm long) had eaten a 3 cm long goby. Two out of two *S. variegatus* had fish in their stomachs; one individual 13 cm long had eaten a 3.5 cm juvenile scarid, and the other (12 cm long) had eaten a 4.5 cm *M. atrodorsalis*. The piscivorous habits of *A. chinensis* are well documented in Hobson (1974) and Haitt and Strassburg (1960). Among the possible causes for the declines of seasonal fishes, it is very likely that predation is the most significant for seasonal fishes which recruit as juveniles.

Attrition factors probably affect each species differently. It is interesting to notice in Figure 6 that *G. traceyi* has a higher recruitment and attrition rate than *P. vailui*, and that the attrition rate implies a complete turnover in *G. traceyi* individuals every 15 months. Seasonal recruitment and attrition cause the density ratio of *P. vaiuli* to *G. traceyi* to vary nonrandomly, alternately favoring one and then the other in different seasons (Figure 7). Early recruitment of juvenile *P. vaiuli* caused the ratio to favor this species in March, until *G. traceyi* began recruiting later that month. The ratio then favored *G. traceyi*. A few months after recruitment had ceased and the juveniles of both species had grown larger, the ratios shifted to favor the larger species, *P. vaiuli*. This was due to a lower attrition rate for larger adult *P. vaiuli* compared to smaller adult *G. traceyi* (Figure 6).

The density declines of *C. rhodochrous*, *S. variegatus* and *A. chinensis* did not seem to be a result of predation. The relationship shown in Figure 5 suggests the possibility that the density variations of these picivorous fishes may be an aggregating response to a temporal and spatial variance in the abundance of seasonal forage fish. The correlation coefficient calculated between the variance of the four combined prey species and the variance of the three combined predator species was significant to three places (Ts=7.67xxx, N=37). One fact must be pointed out in order to understand the mechanism that accounts for the increase and decrease of these predators on the census areas. The average densities of *P. vaiuli* and *G. traceyi* combined on the permanent transects on March 30, 1979, as extrapolated from Figure 4 are all higher than was the average density of only 60 individuals per 100 m^2 counted on the 249 m transect for that same date. The census areas in this study probably recruited more than an "average" number of juveniles because they were located between pairs of sand channels and contained irregular coral features with numerous depressions. Increases of *A. chinensis*, *S. variegatus* and *C. rhodochrous* on the census areas may be a result of local individuals aggregating in areas where and when densities of other juvenile fishes are high. At other times of the year potential prey densities become low and the attraction for predators ceases to exist. Predator densities decline on the census areas because individuals spread out to hunt food over larger areas of the reef to satisfy their needs. This same process may explain the seasonal occurrance of large game fishes which use the artificial reef for habitat only during certain months of the year.

CONCLUSION:

Explanations and implications of seasonality

No seasonal spawning peaks were observed during this study and, in fact, some seasonally recruiting species (e.g., P. vaiuli) spawn year-round. Maximum juvenile settlement for seasonal species occurred between March and June; only a few juveniles settled out during other months. Even those species which recruited to the artificial reef later in the year probably settled out elsewhere between March and June. Local fishermen say that first-day juvenile M. flavolineatus for example, come over the reef twice a year only in May and between November and December.

The factors responsible for imposing patterns of seasonal spawning and recruitment within a 3 to 4 month span are not understood. Maximum settlement, south of the equator, occurs between December and February at One Tree Island, South Barrier Reef (Russel et al. 1977) while major spawning peaks have been observed at the same time by Talbot (in Johannes 1978) on Lizard Island in the Northern Barrier Reef. South of Guam in Palau and Yap, Johannes (1978) determined that major spawning peaks occur during March, April and May. Spawning peaks have also been observed in Hawaii between March and May and again in October (Watson and Leis 1974). Such patterns have been attributed to seasonal differences in water temperature (Munro et al. 1973, Talbot et al. 1978, Russel et al. 1974), to seasonally light current patterns which favor a greater number of larvae returning to their island of origin (Johannes 1978) and to particularly abundant planktonic food at certain times of the year (Russell et al. 1977). The ocean surface temperatures on Guam normally range between 27°C and 29°C while fish settlement occurs sometime between the extreme months. Pilot charts of the Pacific basin show that the westward flowing northern equatorial current which runs directly into Guam slackens in March but it is not at its slackest until the summer doldrum months.

A more direct relationship may exist between available planktonic food and maximum settlement months. Boodlea composita, for example, forms a thick green carpet inside the reef margin. Starting late in February it begins to produce gametes after which the carpet is loosened from the substratum and does not grow back until late in the summer (Roy T. Tsuda, personal communication). The loose algal material transported offshore may be of some indirect nutritional value to larval fish. Other algae die back seasonally. According to Peterson (1972), the seasonality of Caulerpa racemosa may be controlled by minus tides occuring between 0900 and 1500 hours. These tides start in March and may cause the desiccation of other algae as well (Tsuda 1972, 1974). The resulting particulate material from these periodic diebacks, transported offshore, may also contribute indirectly to larval nourishment at certain times of the year.

Seasonal losses

Of the possible factors contributing to the disappearance of so many fish following recruitment, disease, starvation, environmental catastrophes, emigration and old age probably played minor roles. It is unlikely that all these seasonal fishes, representing several families and many dietary types, could have become diseased or starved during the same time of year. There were no environmental catastrophes such as major storms during this study and most attrition losses occurred before settled juveniles were six months old or old enough to emigrate.

The majority of the evidence in this study suggests that predation was the most significant attrition factor, particularly for the juveniles. According to Hobson (1972), predators distinguish between prey primarily on the basis of size. Because juveniles are smaller than adults, they may be the prey of more age groups of more predator species. This could be the reason why some species delay metamorphosis until juveniles have grown to a certain size and why most species which maintain small home ranges all their lives are smaller than those that change their habitat preference with age (Helfman 1978). Predation appeared to have a strong affect on fish abundance in this study as it has appeared to have had in others (Smith and Tyler 1972, Helfman 1978, and Talbot et al. 1978).

Population and community regulation

The limitations of space on coral reefs has been regarded as an important factor affecting the structure of territorial reef fish assembleges (Helfman 1978). Consequently, fish assembleges may be regarded as competitive systems in which the competitive exclusion principle might apply. However, Sale (1977) conjectures that among many reef fish species the competitive exclusion principle may not apply and the unusually high diversity of fishes in the tropics is a result of the existence of groups of fishes, referred to as guilds, that can utilize and defend the same types of substrata. The diversity in a guild is maintained by random vacancies occurring on the reef throughout the year. These vacancies become filled by the first guild member that comes upon the opportunity. Random factors of available space and the presence of a colonizing fish make it possible for even the rarer species in a guild to be first in line for space at least a few times a year. The fact that reef fish generally produce a high abundance of offspring, insures that only a few winners of space are needed for a rare species to have larval representation in future lotteries for space.

The results of this study contradict this theory. Rather than the limited amount of reef space becoming filled as it became available throughout the year, there were long periods of time when space was not being colonized as it became available. Available reef space may still have been limited; however, during most of the year there were too few individuals to colonize all vacancies. Only in the spring when fish stocks are replenished en mass by settling larvae are there fish enough to recolonize the entire reef area.

If predator abundance is limited by the low levels of prey available in fall and winter months, then the simultaneous settling of juveniles in spring could swamp them with prey. Assuming that most of the spring juveniles in this study are vulnerable to the same predators in their local area, then the predators will probably diminish the number of each species proportionally to their respective relative abundadance. Those species with greater numbers of juveniles will be eaten more often, at least initially. Consequently, the juveniles of rarerspecies have a statistical change to be overlooked and grow to gain a better refuge in size and experience. An even level of prey throughout the year might support greater numbers of predators and make it less likely that rare species will successfully colonize a reef vacancy and mature.

This seasonality study is distinctive from others in that changes in fish assembleges and fish abundance were observed on permanent transects covering large areas of the natural reef, and not strictly on small isolated artificial reefs like those studied by other (Sale and Dybdahl, 1975; Talbot et al., 1978; and Russel et al., 1977). Those artificial reef studies determined that there was considerable variability between years in species and numbers which colonized the reefs. In contrast, this study suggested that the relative dominance of the four seasonal transect species during and following the maximum recruitment months remained essentially the same on all the transects and between the years even though the total number of recruits did vary between years.

The populations of small forage fishes in this study maintain a dynamic balance through alternating heavy recruitment and decimation due to predation which results in a periodic accumulation of vacant reef space. A high level of diversity is maintained because a high percentage of each species population is turned over each year. Predators are effectively interfering (Pain 1966) with the establishment of a static equilibrium among species in a guild that might result in the competitive exclusion of some.

Impact of the artificial reef on the surrounding area

The data presented in this study indicate ARAB-I had no detectable positive or negative impact on the surrounding reef community. This conclusion is based on comparisons between counts made on the same transects before and after the barge's emplacement, and on counts made on control transects over 70 m away from the barge.

Evaluation of the artificial reef

Steel ships generally make good artificial reefs because they provide structures which fish use as a refuge by day or night, and as a feeding substrata. The structural configuration of the modified LCM barge used in this study provided opportunity to evaluate the relative recruitment efficiency of its many substructures. The exterior vertical and horizontal surfaces attracted grazing scarids and acanthurids but this probably did not affect their abundance in the area. The vertical relief of the barge attracted planktivores, projections on the upper surfaces attracted many juvenile fishes and adult pomacentrids, the horizontal 0.2 m diameter tubes which enclose the barge pan usually contained acanthurids at night. The best attracting structures, however, were vertical overhangs beneath the barge, beneath the tube roof of the barge pan and beneath the engin room deck. These last structures were particularly responsible for the fish abundance on the barge. Coral colonies which continue to develop quickly on the barge will further enhance the local fish abundance and diversity in the future.

Suggestions for improvement

The artificial reef in this study did not attract enough large fishes throughout the year to be popular among spear and bottom fishermen. There was apparently enough habitat provided by the barge for at least four large fishes at a time but there might have been an inadequate supply of food to attract them during most of the year. There was also probably enough habitat for a greater number of resident fishes (e.g. holocentrids) however, their accumulations are slow because the number of growing individuals that could colonize the reef is probably limited by the amount of intermediate size habitats in the area of which ARAB-1 provided very little. A greater overall annual supply of prey may be maintained in the general area if satellite reefs are constructed to provide intermediate and small size habitats. These satellites could be constructed of discarded cement conduits for optimal coral development, and would provide habitat for young adults of large and small species, additional habitat for juveniles to settle on and, if constructed with mid-water floatation devices, an elevated area about which planktivores may feed. Some of the growing fishes (e.g. holocentrids) on these satellites may eventually migrate to and reside in the centrally located barge and hasten the replacement of any individuals of these resident species removed from the barge by fishermen. Evidence presented in this paper suggests that most of the large carnivorous fishes which used the barge were very transitory and may have only been there to feed. If a contrastingly more abundant supply of prey were available in the study area (because of the satellites) throughout the year, then the larger carnivorous fishes caught by fishermen could be replaced again and again throughout the year. A large steel ship would probably make a better artificial reef than ARAB-1 particularly if care is given to its placement. The advantages of a large ship would be its greater vertical relief, its greater diversity and amount of habitat and its greater surface area for the growth of corals. For these advantages to be best developed, the ship should be located in an area with a strong current and where its superstructure will be within 15 meters of the surface for good exposure to the sun. Light penetration will contribute to coral development and strong currents will bring in greater amounts of particulate material and other nutrients upon which planktivores, such as *Naso hexacanthus*, may feed.

SUMMARY:

1. The 120 species of fishes in this study each exhibited one of three patterns in their abundance variation over time. Most species varied in a non-regular manner (irregular species). Other species which all occured on the artificial reef exhibited net increases in their abundance (accumulating species). The remaining sixteen species exhibited distinct cyclical variations in their abundance (seasonal species) which were repeated twice during the nearly two years of this project.

2. Seasonal species became more abundant at certain times of the

year because of either: (1) a greater number of larvae setting directly out of the water column at the study site between March and June, (2) a greater number of older juveniles and young adults appearing on the census areas later in the year or, (3) a greater number of mature adults appearing on the census areas between April and July.

3. Juveniles were distributed over the substratum in a clumped arrangement. This seemed to be because juveniles of most species occured more abundantly on those substrata that provided the best refuge from predators and because the substratum varied considerably from one area to another.

4. Increases of most seasonal species at the study site were by means of larvae settling directly on to the reef or by immigrations of older juveniles that settled out elsewhere. The major cause of the decreases following the recruitment months appreared to be predation. By contrast, the increase and decrease of the three seasonal predatory species appeared to be a distributional response to a spacio-temperal variation in prey abundance.

5. The distributional response of predators to spacio-temperal variations in prey abundance illustrates that in order to attract large carnivorous fishes to an artificial reef or any point area, a prey density must be maintained in that area that will contrast with lower prey densities in the surrounding area. This presents a question, should artificial reefs be designed to provide habitat for big fish as is traditionally thought or should they be designed to provide habitat for small fish which will attract large fish. A suggestion is made to establish intermediate size habitates or satellite in conjunction with large habitat structures.

RECOMMENDATIONS:

1. Monitoring of ARAB-1 should be de-emphasized except for the months between February and July so that more information can be gathered on the dynamics of seasonality.

2. Damaged cement conduits should be placed in piles near ARAB-1.

3. Efforts should be made to secure another larger ship for creating an artificial reef off of Facpi Point.

Report Prepared by R. Logan Kock

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Table 1. Schedule of fish counts made on the three transect groups and on the artificial reef.

TRANSECT GROUP	FIRST COUNT	LAST COUNT	TOTAL NO. OF COUNTS	AVERAGE NO. PER MONTH
A and B	3 XI 77	26 V 79	37	2
C and D	3 XI 77	21 III 79	16	2/month counted
E, F, and G	11 IX 78	26 V 79	19	2
Artificial Reef	3 XI 77	26 V 79	39	2

Table 2. List of fishes seen during the study. Asterisks indicate fishes seen during three fish counts made in 1977 prior to sinking of the LCM. "Abundant" indicates that 15 or more individuals were usually seen in the study area on any given day. "Common" fish were seen on every count but were not as numerous. "Rare" species were not observed on every count. "T" indicates fishes observed on natural reef transects. "B" indicates fishes observed on the artificial reef. "N" seen at night only.

	RARE	COMMON	ABUNDANT
ACANTHURIDAE			
Acanthurus glaucopareius Cuvier	BT		
**A. mata* (Cuvier and Valenciennes)	BT		
**A. nigrofuscus* Forskal		T	B
A. pyroferus Kittlitz	B		
**Ctenochaetus striatus* (Quoy and Gaimard)		T	B
**Naso lituratus* Bloch and Schneider			T
N. unicornis (Forskal)	T		
Paracanthus hepatus (Linnaeus)	T		
**Zebrasoma flavescens* (Bennett)	B		
APOGONIDAE			
Apogon exostigma (Jordan and Starks)		B	
Apogon sp. 1 (Yellow)		B	
Apogon sp. 2		B	
Cheilodipterus macrodon (Lacépède)			B
**C. quinquelineatus* Cuvier and Valenciennes		B	
AULOSTOMIDAE			
**Aulostomus chinensis* (Linnaeus)	BT		
BALISTIDAE			
**Balistapus undulatus* (Mungo Park)	T		
**Melichthys vidua* Solander		T	
**Sufflamen bursa* (Bloch and Schneider)			T
BLENNIIDAE			
**Meiacanthus atrodorsalis* (Gunther)	B	T	
CANTHIGASTERIDAE			
**Canthigaster solandri* (Richardson)		B	T
C. valentini (Bleeker)		B	

Table 2. (Continued)

	RARE	COMMON	ABUNDANT
CARANGIDAE			
Caranx melampygus Cuvier	BT		
CHAETODONTIDAE			
Chaetodon auriga Forskal	T		
C. ephippium Cuvier	T		
C. lunula (Lacépède)		T	
*_C. mertensii_ Cuvier		T	
C. miliaris Quoy and Gaimard	T		
C. ornatissimus Cuvier and Valenciennes	T		
C. punctatofasciatus Cuvier		T	
C. reticulatus Cuvier	T		
Forcipiger flavissimus Jordon and McGregor		TB	
F. longirostris (Broussonet)	B		
Heniochus chrysostomus Cuvier and Valenciennes		B	
CIRRHITIDAE			
*_Cirrhitichthys falco_ Randall		B	T
*_Paracirrhites arcatus_ (Cuvier and Valenciennes)	TB		
P. forsteri (Bloch and Schneider)	T		
FISTULARIIDAE			
Fistularia petimba Lacépède	T		
GOBIIDAE			
*_Eleotroides strigatus_ (Broussonet)	T		
*_Nemateleotris magnificus_ Fowler		T	
*_Ptereleotris evides_ (Jordan and Jubbs)			T
HOLOCENTRIDAE			
*_Adioryx caudimaculatus_ (Ruppell)			B
*_A. ruber_ (Forskal)			B
*_A. spinifer_ Jordan and Evermann		B	
*_Flammeo sammara_ Jordan and Evermann	B		
*_Myripristis murdjan_ (Forskal)			B
LABRIDAE			
Anampses twistii Bleeker	T		
Cheilinus chlorourus (Bloch)	T		
C. fasciatus (Bloch)	TB		
C. rhodochrous Gunther		T	
C. trilobatus Lacépède	T		

Table 2. (Continued)

	RARE	COMMON	ABUNDANT
Cirrhilabrus sp.			T
Coris gaimardi (Quoy and Gaimard)	T		
*_Epibulus insidiator_ (Pallas)		T	
*_Gomphosus varius_ Lacépède	T		
Halichoeres biocellatus Schultz			T
*_H. centiquadrus_ Lacepede	TB		
Hemigymnus melapterus (Bloch)	T		
*_Hemipteronotus taeniurus_ (Lacépède)	T		
*_Hologymnosus semidiscus_ (Lacépède)	T		
Labroides bicolor Fowler and Bean		B	
*_L. dimidiatus_ (Cuvier and Valenciennes)		T	
*_Macropharyngodon meleagris_ (Cuvier and Valenciennes)			T
Stethojulis axillaris (Quoy and Gaimard)		T	
S. bandenansis (Bleeker)		T	
*_Thalassoma hardwicki_ (Bennett)	T		
*_T. lunare_ (Linnaeus)	T		
*_T. lutescens_ (Lay and Bennett)		BT	
LETHERINIDAE			
Lethrinus reticulatus Cuvier and Valenciennes	T		
Monotaxis grandoculis (Forskal)		B	
LUTJANIDAE			
Lutjanus bohar (Forskal)	B		
L. fulvus (Bleeker)	B		
L. monostigma (Cuvier and Valenciennes)	B		
L. sebae (Cuvier and Valenciennes)	B		
_L._ sp.	B		
Macolor niger (Forskal)	B		
MONOCANTHIDAE			
Aluteres scriptus (Forster)			
Cantherhines pardalis (Ruppell)			
*_Pervagor melanocephalus_ (Bleeker)		T	
MUGILOIDIDAE			
Parapercis cephalopunctata (Seale)	T		
*_P. clathrata_ Ogilby		T	
MULLIDAE			
Mulloidichthys flavolineatus (Lacépède)	B		

Table 2. (Continued)

	RARE	COMMON	ABUNDANT
Parupeneus barberinus (Lacépède)	B		
P. bifasciatus (Lacépède)		BT	
**P. cyclostomus* (Lacépède)		T	
P. pleurostigma (Bennett)	B		
**P. trifasciatus* (Lacépède)			BT
MURAENIDAE			
Gymnothorax sp.	B		
POMACANTHIDAE			
Centropyge flavissimus (Cuvier)		T	
**C. shepardi* Randall		BT	
Holacanthus trimaculatus Cuvier		BT	
**Pomacanthus diacanthus* (Boddaert)	B		
P. imperator (Bloch)	B		
POMACENTRIDAE			
Chromis acares Randall and Swerdloff		B	
C. agilis Smith		B	
C. xanthura (Bleeker)		B	
**Dascyllus reticulatus* (Richardson)	B		
D. trimaculatus (Ruppell)			B
**Glyphidodontops traceyi* (Woods and Schultz)			B
**Plectroglyphidodon lacrymatus* (Quoy and Gaimard)		T	
P. johnstonianus Fowler	T		
**Pomacentrus vaiuli* (Jordan and Seale)			T
POMADASYIDAE			
Plectorhynchus orientalis (Bloch)	B		
SCARIDAE			
**Leptoscarus vaigiensis* (Quoy and Gaimard)	T		
**Scarops rubroviolaceus* (Bleeker)		T	
Scarus cholorodon Jenyns			TB
**S. lepidis* Jenyns	TB		
S. sordidus Forskal	B	T	
S. venosus Cuvier and Valenciennes			
SERRANIDAE			
**Epinephelus fasciatus* (Forskal)		TB	
E. sp.	B		
E. tauvina (Forskal)	B		
**Cephalopholis urodelus* (Bloch and Schneider)		T	

Table 2. (Continued)

	RARE	COMMON	ABUNDANT
SIGANIDAE			
Siganus guttatus (Bloch)	T		
SYNODONTIDAE			
Synodus variegatus (Lacépède)		T	
TERADONTIDAE			
Ostracion cubicus Linnaeus	T		
O. meleagris Shaw	T		
*_Tetraodon hispidus_ Linnaeus	T		
ZANCLIDAE			
*_Zanclus cornutus_ (Linnaeus)		B	

Table 3. Classification of variations in abundance of many of the common and abundant fishes counted on transects A and B. Fishes were classified as seasonal, accumulating or irregular[1] using median test in two-by-two contingency tables similar to those in Table 4. (S≡ seasonal; A≡ accumulating; NS≡ not significant; *≡ p<.05; **≡ p<.01; ***≡ p<.001). The numbers in parentheses after S are months tested for greater abundance.

ARTIFICIAL REEF SPECIES				
Species	Median density value	Variation tested for	Significance	Classification
A. nigrofuscus	2	A	*	slightly more abundant second year
C. striatus	11	A	NS	irregular
A. exostigma	2	A	NS,***	accumulating through additional juveniles, seasonal
Apogon sp. (yellow)	2	S,A	NS,***	accumulating through additional juveniles, seasonal
C. macrodon (adult)	8	A	NS	small resident population varied randomly
C. macrodon (juvenile)	0	S(6-7)	***	seasonal both years
M. atrodorsalis	2	S,A	NS,NS	irregular, but was slightly seasonal
C. solandri	3	A	NS	irregular
F. flavissimus	3	A	NS	irregular
H. chrysostomus	2	A	NS	small resident population varied randomly

Table 3. (Continued)

ARTIFICIAL REEF SPECIES

Species	Median density value	Variation tested for	Significance	Classification
C. falco	1	A	NS	irregular
A. caudimaculatus	11	A	***	accumulating
A. ruber	5	A	***	accumulating
A. spinifer	3	A	NS	small resident population varied randomly
M. murdjan	6	A	***	accumulating
H. centiquadrus	0	A	NS	irregular
T. lutescens	2	A	NS	irregular
M. flavolineatus	0	S,A	NS,***	accumulating through additional juveniles, seasonal
P. trifasciatus	2	A	NS	irregular
C. acares	1	S(2-7)	NS	seasonal, but no recruitment 1979
C. agilis	1	S(2-6)	NS	seasonal, but no recruitment 1979
C. xanthura (adult)	0	A	*	accumulating
C. xanthura (juvenile)	0	S(2-5)	***	seasonal both years
D. trimaculatus	5	A	***	accumulating
G. traceyi	0	S(3-8)	*	recruitment low on artificial surfaces seasonal
P. vaiuli	1	S(2-7)	*	recruitment low on artificial surfaces seasonal

Table 3. (Continued)

ARTIFICIAL REEF SPECIES				
Species	Median density value	Variation tested for	Significance	Classification
S. cholorodon	1	A	NS	irregular
S. venosus	1	A	NS	irregular
E. faciatus	4	A	NS	random
Z. cornutus	0	A	*	few more individuals second year
NATURAL SUBSTRATUM SPECIES				
A. nigrofuscus	3	A	NS	irregular
C. striatus	0	A	NS	irregular
N. lituratus	0	A	NS	irregular
M. vidua	0	A	NS	irregular
S. bursa	1	A	NS	irregular
M. atrodorsalis	0	S(4-9)	*	seasonal
C. solandri	1	A	NS	irregular
C. lunula	0	A	NS	irregular
C. mertensii	0	A	NS	irregular
C. punctatofasciatus	1	A	NS	irregular
F. flavissimus	0	A	NS	irregular
C. falco	1	A	NS	irregular
N. magnificus	0	A	NS	irregular
P. evides	0	A	NS	irregular
Cirrhilabrus sp.	7	S(4-9)	***	seasonal
E. insidiator	1	A	NS	irregular

Table 3. (Continued)

NATURAL SUBSTRATUM SPECIES				
Species	Median density value	Variation tested for	Significance	Classification
H. biocellatus	14	S(3-9)	***	seasonal
S. axillaris	0	A	NS	irregular
S. bandenansis	0	A	NS	irregular
P. bifasciatus	0	A	NS	irregular
P. cyclostomus	0	A	NS	irregular
P. trifasciatus	0	A	NS	irregular
C. flavissimus	0	A	NS	irregular
C. shepardi	0	A	NS	irregular
G. traceyi	74	S(3-9)	***	seasonal
P. lacrymatus	0	S(3-7)	*	seasonal
P. vaiuli	69	S(3-7)	**	seasonal
S. cholorodon	0	A	NS	irregular
S. venosus	0	A	NS	irregular
all scarids	2	A	NS	irregular
C. urodelus	1	A	NS	irregular

[1] Seasonal=species which are significantly more abundant during certain portions of the year. Accumulating=species that had significantly higher percentage of counts with densities greater than the median during the second half set of observations. Irregular=no significant pattern of accumulation or seasonality.

[2] Artificial reef-median densities are based on the total number of individuals on the LCM; approximately 70 m^2. The densities on the transects are in units of individuals per 100 m^2.

Table 4. Two-by-two test of independence using the G-statistic[1] with Yate's correction to determine if certain predators were more abundant during those months of the year when prey individuals were more abundant.

Synodus variegatus[2] on the artificial reef

s=2.01 $\bar{Y}$=2.10 Median=1.5 N=39

	NO. OF COUNTS with ≥ 3 individuals	NO. OF COUNTS with <3 individuals
April-July	11	2
Other Months	2	24

G. adj = 20.46**

	NO. OF COUNTS with ≥ 2 individuals	NO. OF COUNTS with <2 individuals
March-Sept.	16	7
Other Months	4	12

G. adj = 5.98*

Aulostomus chinensis[2] on the artificial reef

s=1.74 $\bar{Y}$=2.03 Median=2 N=39

	NO. OF COUNTS with ≥ 3 individuals	NO. OF COUNTS with <3 individuals
April-July	8	5
Other Months	5	21

G. adj = 5.10*

	NO. OF COUNTS with ≥ 2 individuals	NO. OF COUNTS with <2 individuals
March-Sept.	19	4
Other Months	6	10

G. adj = 6.57*

Cheilinus rhodochrous[3] on transects A and B

s=1.64 $\bar{Y}$=1.84 Median=1 N=37

	NO. OF COUNTS with ≥ 3 individuals	NO. OF COUNTS with <3 individuals
April-July	7	6
Other Months	1	23

G. adj = 9.39**

	NO. OF COUNTS with ≥ 2 individuals	NO. OF COUNTS with <2 individuals
March-Sept.	14	5
Other Months	4	14

G. adj = 8.16**

*$P<.025$

**$P<.005$

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[1] Sokal and Rohlf (1969:591)

[2] Total Number counted on artificial reef.

[3] No. of individuals per 100m^2 transect area.

Table 5. Coefficients of dispersion[1] calculated between successively larger groupings of contigious $6m^2$ census quadrats to determine how juveniles and adults were distributed along the 249-meter long transects.

	NO. OF QUADRATS PER GROUP	QUADRATS AREA IN $METERS^2$	NO. OF GROUPS	MEAN NO. OF FISH	CD=
JUVENILES	1	6	83	2.54	6.27***
	3	18	27	7.74	9.99***
	5	30	16	13.06	8.00***
	7	42	11	18.73	7.21***
	10	60	8	26.13	7.16***
	15	90	5	41.6	10.44***
ADULTS	1	6	83	.84	1.01NS
	3	18	27	2.33	1.28NS
	5	30	16	4.13	1.27NS
	7	42	11	5.82	1.02NS
	10	60	8	8.00	1.43NS
	15	90	5	12.20	1.46NS

[1] Sokal and Rohf (1969:88) ***P<.001

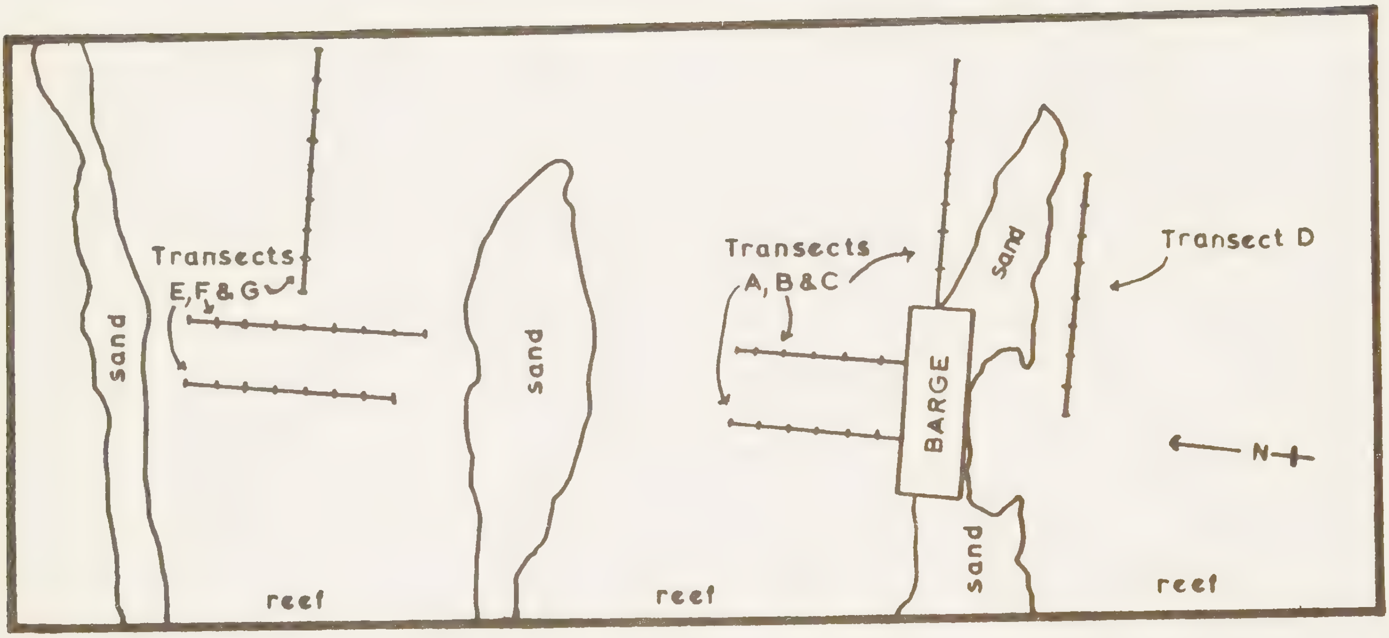

sand
Transects
E,F & G
reef
sand
reef
Transects
A, B & C
BARGE
sand
sand
Transect D
N
reef

Figure 1. Arrangement of transects relative to artificial reef.

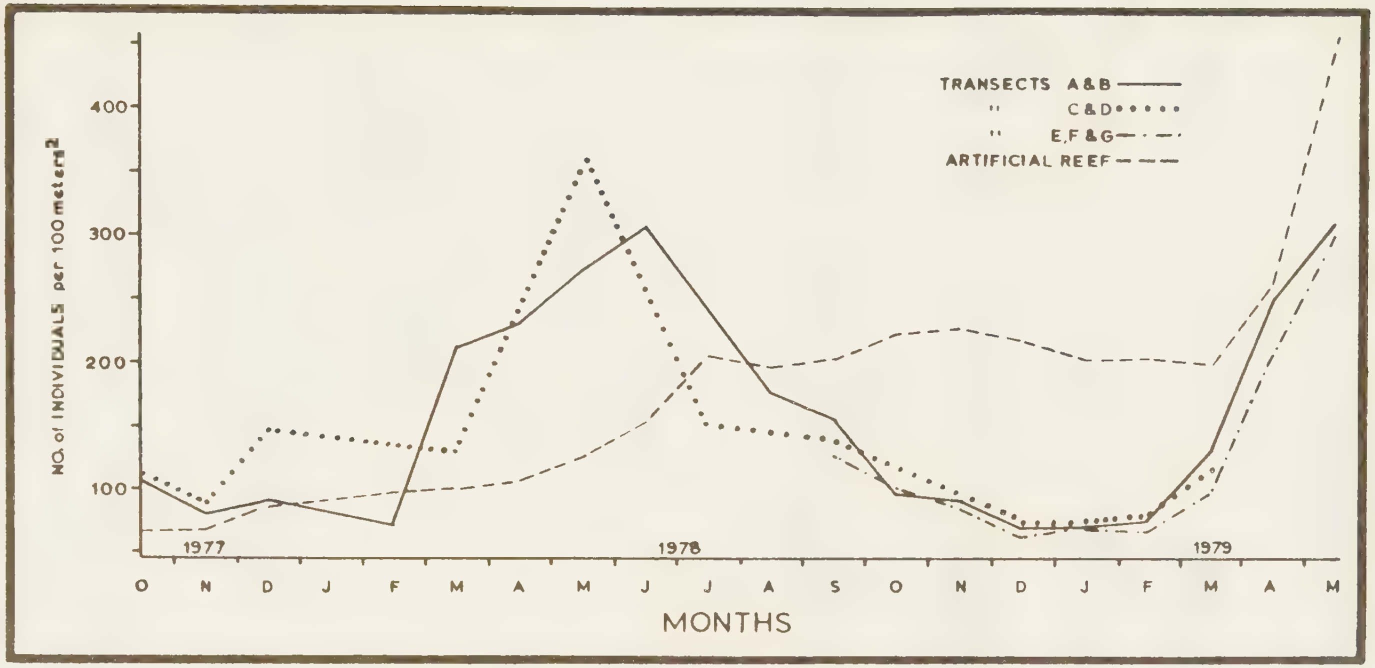


Figure 2. Overall fish abundance variation on the three transect groups and the artificial reef between October 1977 to May 1979. Hash marks along abcissus approximate actual date of count.

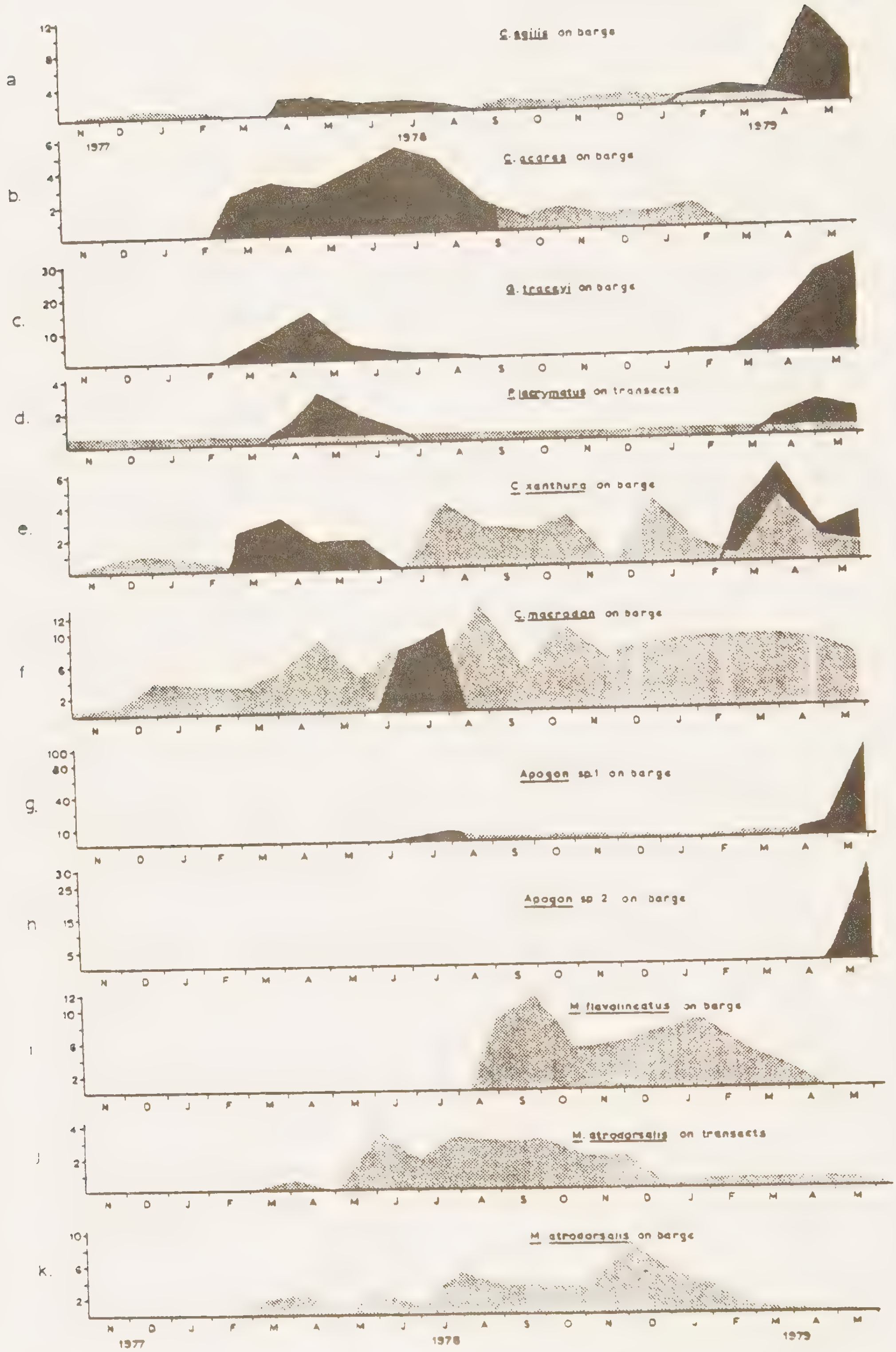
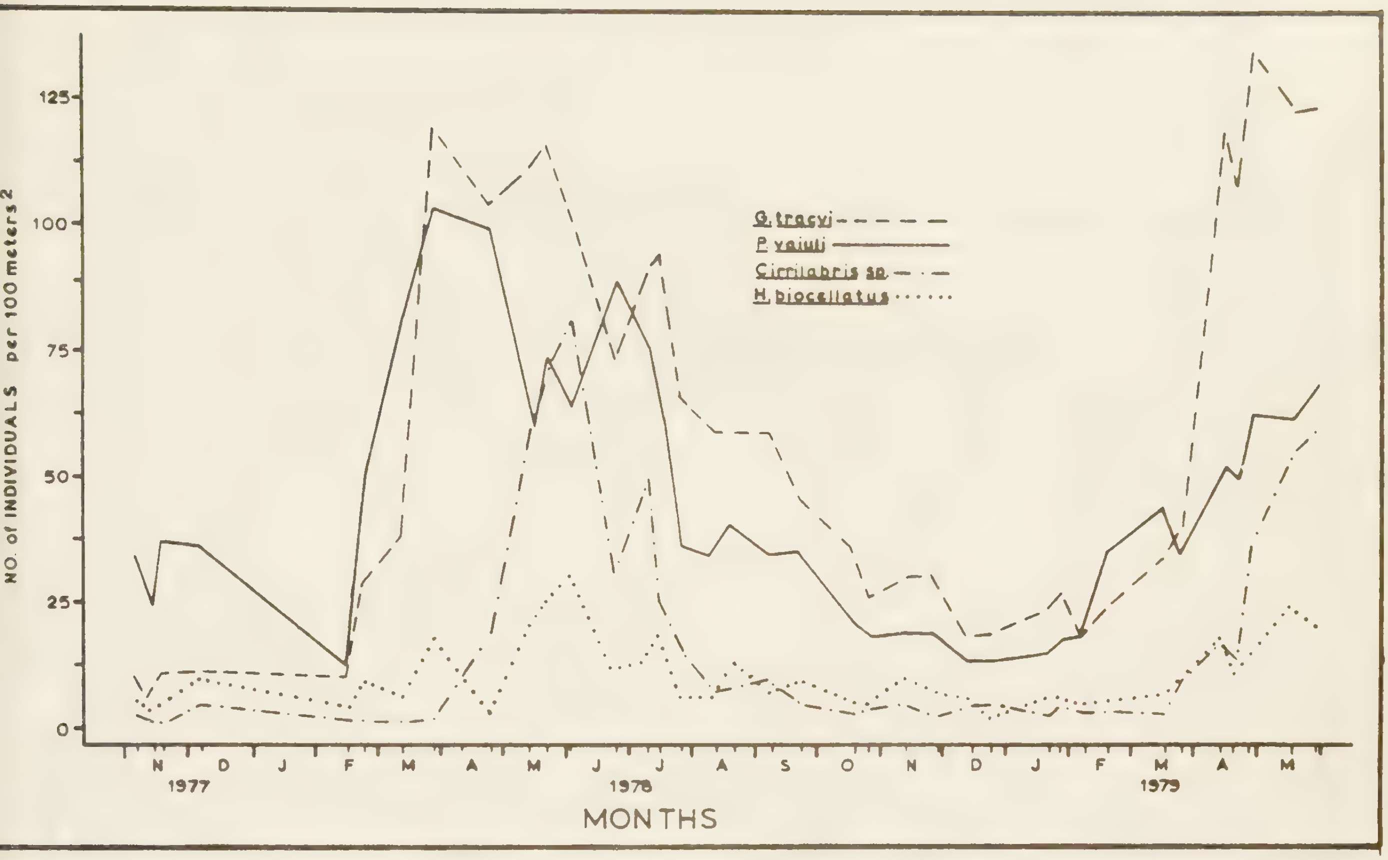
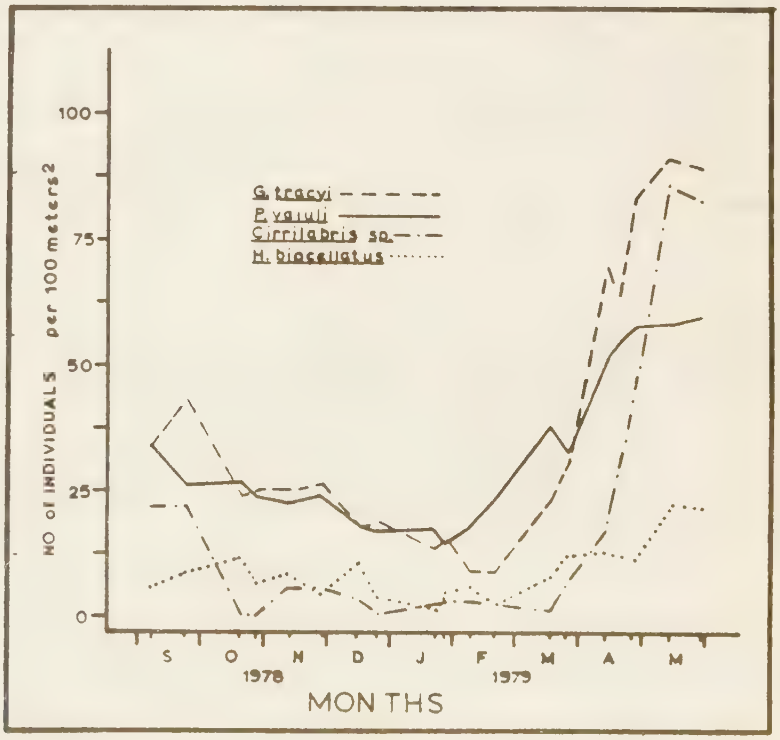


Figure 3. Abundance variation of selected seasonal fishes on the artificial reef (barge) and transects. Density values, given on the ordinate, are number of individuals absolute on the barge or number of individuals per 100 m^2 on transects A and B. Dark areas indicate young juveniles, light areas indicate older juveniles or adults.





igure 4. Variations in abundance of the four most abundant transect fish species. Shown are the variations on transect group A and B (above) and transect E, F, and G (right).

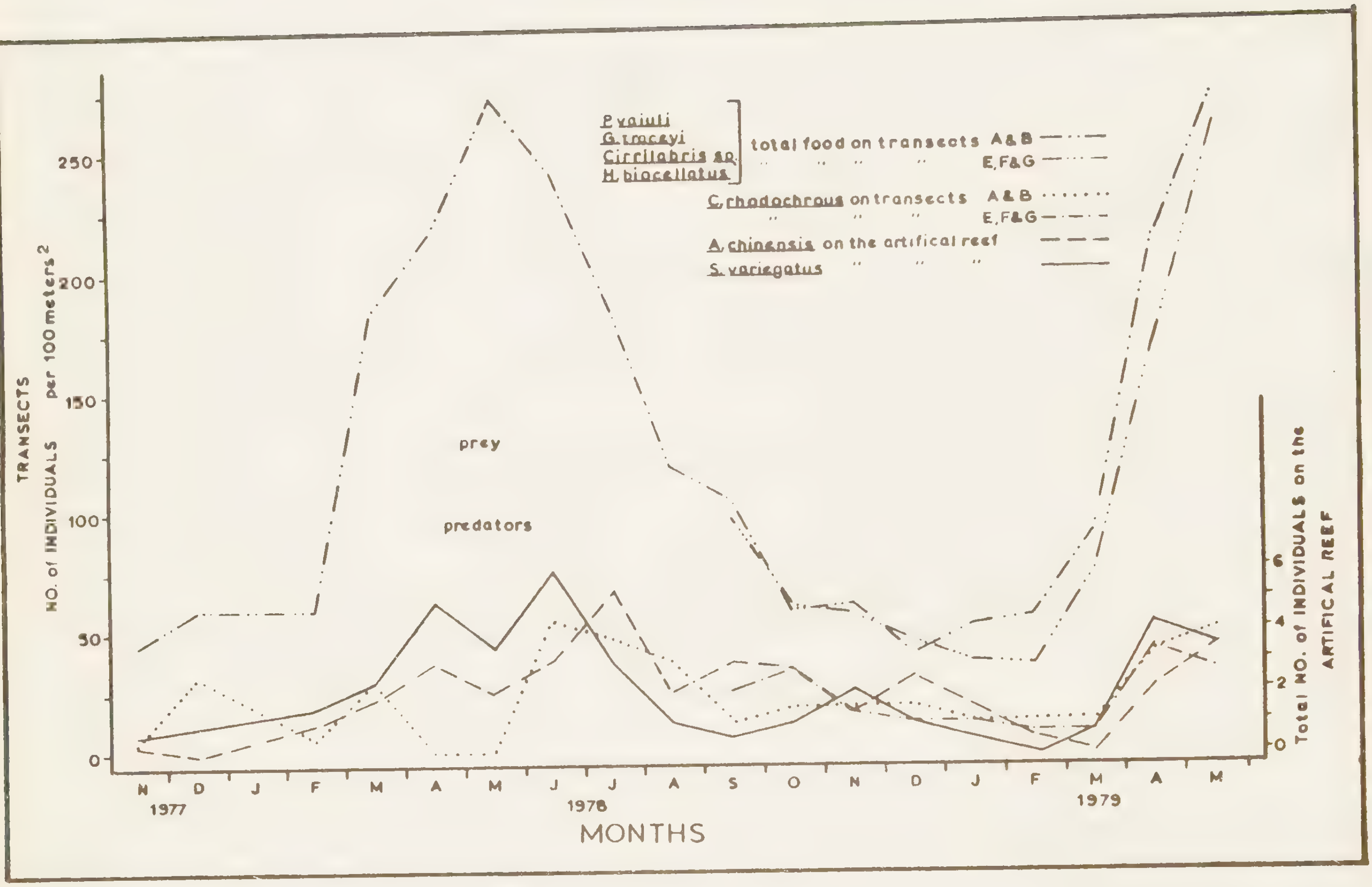


Figure 5. The densities of the four most abundant transect prey species have been added together as total prey for each count and averaged for each month. These averages are graphed against the monthly averages of the three resident predator species discussed in the text. Density values for C. rhodochrous are determined from the right hand density scale by applying the units, number of individuals per 100 m2.

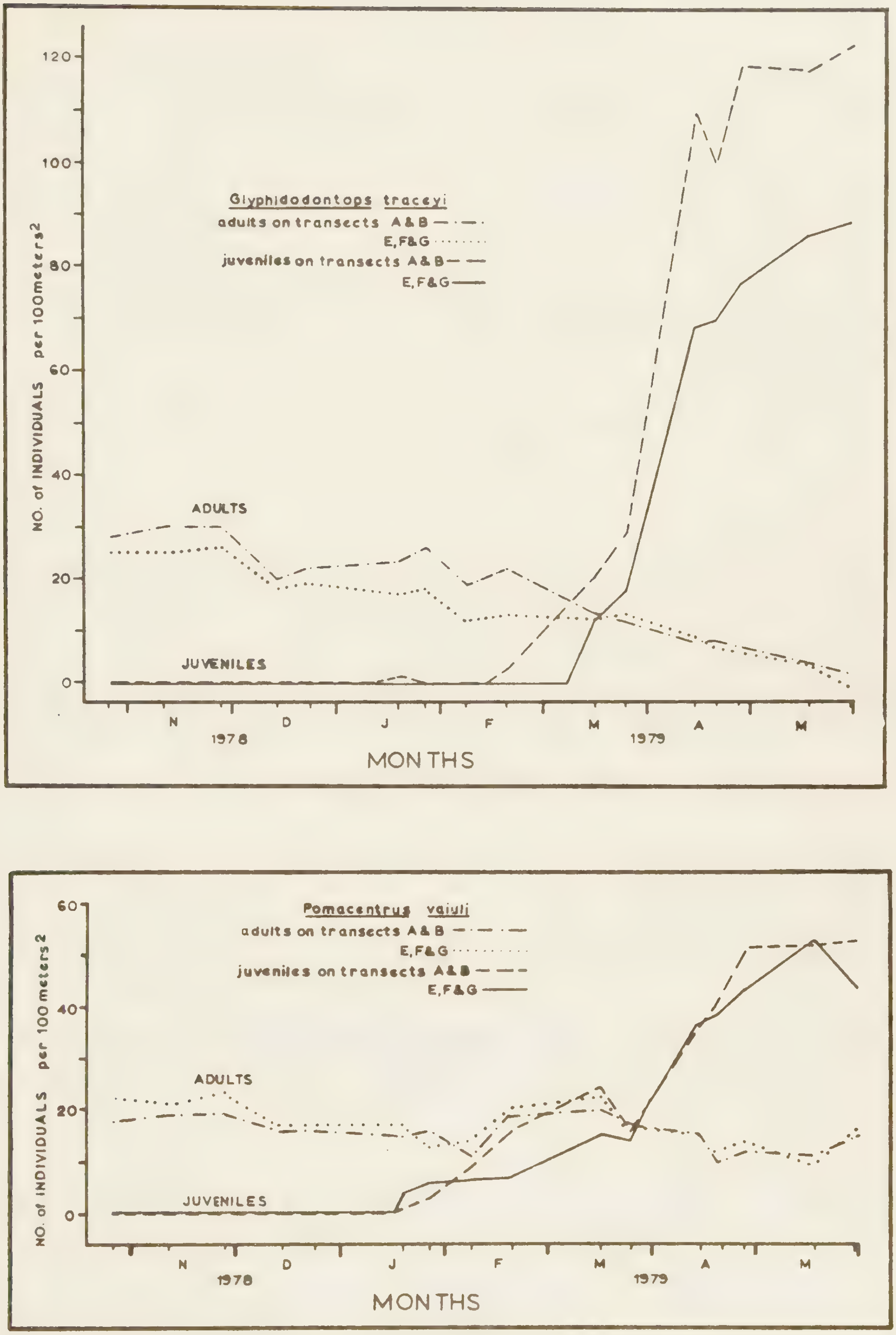


Figure 6. Comparison of adult-juvenile abundance variations between *P. vaiuli* and *G. traceyi*.

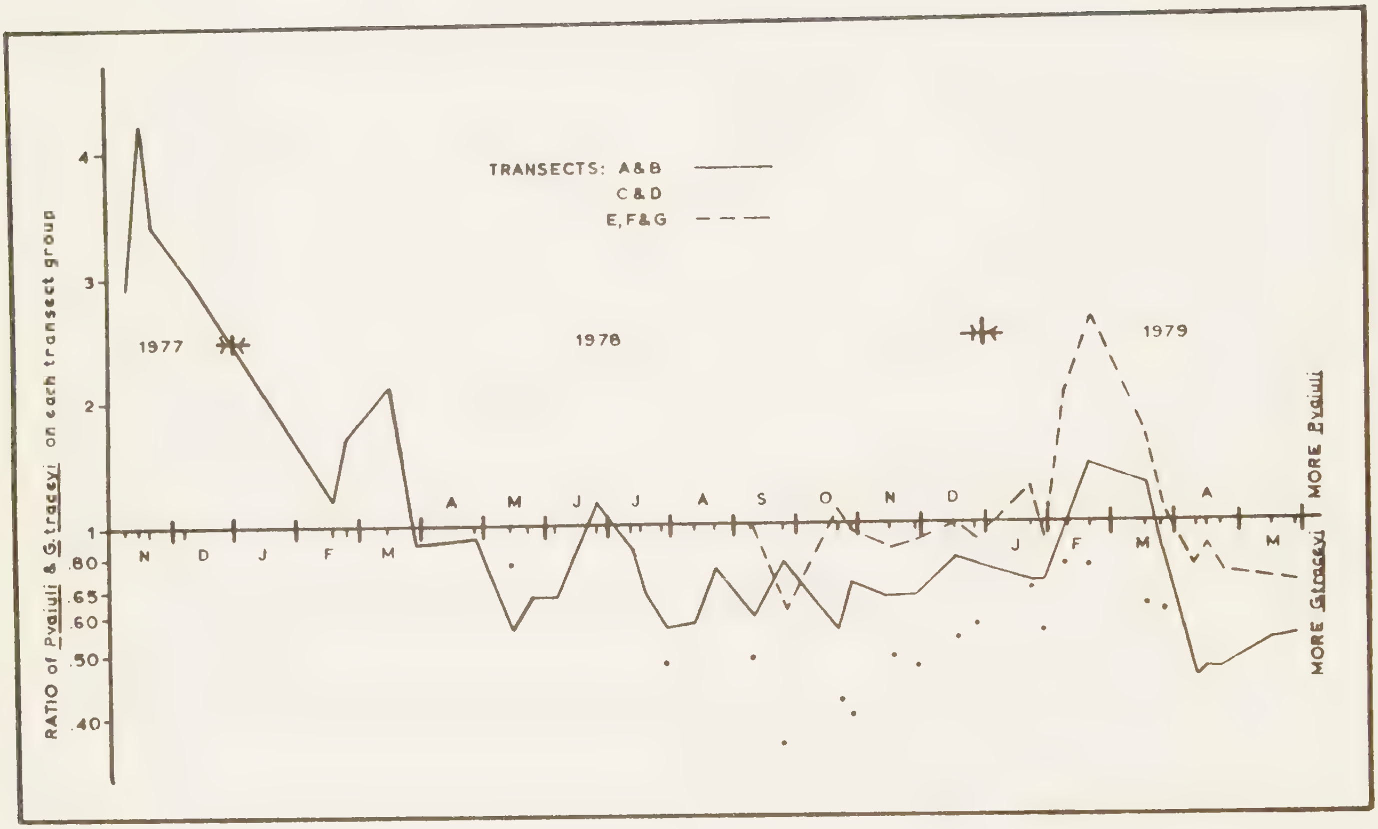


Figure 7. Variation in abundance ratio between P. vaiuli and G. traceyi on the transect groups. The trends are similar on each.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

TERRITORY: Guam

PROJECT NO.: FW-2R-16

JOB NO.: F-7

PROJECT TITLE: Guam Fish and Wildlife Investigations

JOB TITLE: Limnological Survey of the Major Streams and Rivers in Guam

PERIOD COVERED: July 1, 1978 to September 30, 1979.

SUMMARY:

Water temperatures and flow rates were collected monthly (June-March) from the Geus River. Work on the Geus River was discontinued after the vegetation cleared during the FY 78 report grew back.

Preliminary biological surveys were conducted on the Inarajan River, Agana Swamp, Naval Communication Station (N.C.S.) pool and two small watersheds in the Fena system. Tables and figures of data collected for these sites are included.

BACKGROUND:

Very few studies have been conducted on the freshwater rivers and streams of Guam. An ecological survey of the Afgayan River mouth was conducted by the Fish and Wildlife Division from July 1, 1968 to June 30, 1972. Salinity, pH, temperature, and lists of organisms collected or observed in the river mouth were included in the Annual Fish and Wildlife Progress Reports. This study dealt primarily with the marine system.

In a preliminary study to rehabilitate the Masso River Reservoir to a public fishing and recreation area (July 1, 1971 to June 30, 1972), small gobies, eels and shrimp are mentioned as the principal inhabitants of the reservoir and river.

A limnological survey of the major streams and rivers of Guam was initiated during the report period of June 30, 1974 to July 1, 1975. The Geus River located in the southern tip of the island and the Lonfit River in the central highlands were investigated. Six species of fish, three species of shrimp and an aquatic gastropod were observed or collected from the Geus River. Five of the six species of fish and two of the three species of shrimp present in the Geus River were also collected or observed from the Lonfit River, as well as two species of aquatic gastropods.

The Geus River was found to be unsuitable for stocking gamefish or for development as a fishing area. The Lonfit River was judged suitable for a stocking and development program, however, this program was deferred because of limited access to the river.

The University of Guam Marine Laboratory Technical Report No. 16 (1974) discusses the physical and limnological components of the Geus River drainage basin. Scientific names and locations where the aquatic organisms were collected or observed are included.

Organisms were collected and catalogued from established stations on the Ylig, Geus and Umatac Rivers during FY 77. Tables and figures containing these data are included in this report. Preliminary stomach content analyses of three fish species, Microsicydium elegans, Eleotris fusca and Chonophorus guamensis were performed during this report period.

The taking of air and water temperatures and flow readings was initiated during this report period. Breeding and reproduction observations of one species of fish are also included.

Water temperatures, flow rates and biological data were collected monthly from permanent monitoring stations on the Geus and Umatac Rivers during FY 1978. The Ylig River was monitored at 3 stations during November 1977 and March 1978.

Seven stations were established on the Ugum and Bubulao River system. All of these stations were monitored at least once during the year. However, stations 1, 2 and 3 were sampled twice. Observations on the spawning of Microsicydium elegans are presented, and a life cycle outline is proposed. An extensive list of the algae collected from the various rivers is included.

OBJECTIVES:

I. To determine the types of aquatic organisms present in the streams and rivers.

II. To publish working keys and descriptions of the freshwater fishes of Guam.

III. To gather biological data on the dominant species.

IV. To determine the distributional patterns of the organisms.

V. To survey the streams and rivers for possible future development for recreational use.

VI. To gather limnological data from small watersheds for possible future development and management purposes.

PROCEDURES:

I. Organisms were collected, identified and catalogued, from established stations on the Geus and Inarajan Rivers and from the NCS pool and Agana Swamp area.

II. Temperature readings were taken at established stations on the Geus River.

III. Flow readings were taken monthly from station IV of the Geus River.

IV. A new site was chosen to study the effects of land clearing on watershed biology and limnology in the Fena Lake watershed area. Preliminary nitrate, phosphate, hardness, pH, temperature and conductivity data were collected.

FINDINGS:

Physical Characteristics of the Rivers

A general river bed description for the rivers of Guam was presented in the FY 78 project report. River bed descriptions for the sampling stations along the Geus River were included in the FY 77 report. All sampling stations from the Inarajan River and Fena study area are characteristically "upstream" in nature. The Agana-Chaot River which flows through the Agana Swamp is characteristically "downstream". The river is choked with silt and vegetation in the areas sampled. A more complete description of the swamp can be found in Randall and Tsuda, 1974. The NCS pool is a sink-hole which has filled with fresh water. Tidal fluctuations influence and may effect the salinity of the pool. The bottom is covered with coral boulders, with an ooze present in the deepest areas.

Flow Readings from the Geus River

Flow readings were recorded monthly from the Geus River using a pigmy flow meter. Monthly flow and rainfall data for FY 79 are presented in Figure 1. The highest recorded rate of flow was greater than 2.4 million gallons/day in October. The rate of flow curve generally follows the annual rainfall curve. Peak rainfall was observed in August yet peak flow was not observed until October. The dry soil may have become saturated during the August rains causing greater run-off during September and October even though less precipitation fell during those months. Another possibility is that the actual rainfall in the Geus River basin was higher during October than August as rainfall on Guam is not evenly distributed and rainfall readings from one area may not reflect actual rainfall in other areas of the island. The greatest increase in flow occurred between August and September which was also observed the previous year. The difference between the 25 fold increase in flow between August and September FY 79 and the 10 fold increase recorded during FY 78 may have been recorded because sampling during FY 79 immediately followed heavy rains. The lowest flow occurred in June, and was 0.12 million gal/day. This reading is slightly higher than the low flow recorded during FY 78. This is probably because more rain fell during June 1978 than June 1977.

Temperature Readings from the Geus River

Water temperature readings were taken monthly from stations on the Geus River. The water and air temperature data obtained for FY 79 are presented in Figure 2; the mean air temperatures were obtained from the National Weather Service, Guam. The highest water temperature was recorded in June. This is probably because of a wide path, cut through the jungle along the river in May 1978 (FY

78), which exposed a long segment of the river to direct sunlight. The decrease in temperature observed in July and August is probably because vegetation in the disturbed area was growning back rapidly. The further decrease in temperatures during September and October is probably also caused by increases in river flow. The fluctuations observed between October and March are not easily explained but may be caused by such variables as cloud cover or rainfall on sampling days. Temperatures and rainfall appear to fluctuate together as increased temperatures appear to occur with increased rainfall. This condition was not expected and is not easily explained.

Water temperatures are generally lowest in the headwater regions, and increase toward the river mouth. When temperature drops occur, in the lower reaches of the river, they are probably caused by inflow of cooler water from tributaries and springs or shading by dense jungle. The latter may have a more significant effect than previously expected. Such decreases are most noticeable during the dry season.

BIOLOGY:

Inarajan River

The Inarajan river was sampled in November 1978 with an electro-fish shocker. The sampling stations on the Inarajan River are indicated in Figure 3. A list of the macrofauna collected is presented in Table 1. Spirogyra sp was the only alga collected from the Inarajan River because flood waters, common during the wet season, remove most benthic flora. A one-time sampling of the aquatic macrofauna of the stations from the Inarajan River included two mollusks, three crustaceans, one insect and six species of fish.

Stations 1 and 3 were approximately 0.5 and 0.25 meters in depth respectively, and were bordered but not shaded by "abandoned coconut grove" vegetation. The stream bed was composed of boulder and coarse alluvium at station 1 and pebble size alluvium and sand at station 3. Station 2 was approximately 1 meter in depth and dense canopy of ravine forest vegetation shaded the river. The stream bed was composed of large boulders and coarse alluvium.

The fauna of all three stations was very similar and the absence of a species from one site is probably because of habitat differences which led to fewer hiding places for the primary consumers. This was most apparent at station 3 where the sandy stream bed afforded little shelter for prey organisms from predators. The fauna was dominated by Kuhlia rupestris at all stations. This species contributed greater than 83% to the total biomass at each station (See Table 3). Tilapia mossambica was not observed or collected from these sites but was observed from the main stem of Inarajan river (U.S, Fish and Wildlife Service, 1978). Kuhlia rupestris and probably T. mossambica are absent upstream from the Inarajan and Fintasa Falls. Goby and shrimp populations are expected to flourish in these areas where K. rupestris is absent.

The abundance of K. rupestris at all sites may be a result of a recent migration of this diadromous species from the ocean. The great number of K. rupestris probably could not be supported by the primary consumers (prey) for an extended period of time. This species may be omnivorous, feeding on sources of food other than primary consumers.

A one time sampling of a river often fails to record rare species or isolated populations. Further sampling should be performed if the proposed Inarajan dam is to be built.

Agana Swamp

The Agana Swamp is located in west central Guam and sampling was conducted during July, August and November 1979. Sampling sites are illustrated in Figure 4. The flora and fauna collected from the swamp are presented in Tables 1 and 2. The aquatic flora consisted of fifteen species from three divisions. The fauna consisted of three species of insects, two mollusks, eight species of fish, and one amphibian and one reptile. With the exception of the eel, Anguilla mamorata, the fauna is believed to be introduced. Aquarium species of fish other than those collected may be present in the swamp as it appears to be a disposal site for pets of people leaving the island.

Station 1 - Swamp

A representative open water pool was selected as station 1. The depth of the pool was approximately 0.3 m during the dry season and increased to approximately 0.67 m during the rainy season.

The open pools in the swamp which hold water all year appear to become a refuge for the aquatic fauna as the water level drops during dry season. Population densities were greater during the dry season than during wet the season when higher water levels enable species to move from the pool.

Tilapia mossambica appeared to dominate fish species in the swamp. Clarius batrachus and Eleotris fusca were common. Tilapia zilli and Poecilia reticulatus were considered rare. No Bufo marinus adults or juveniles were observed near or in the swamp at station 1. This species may breed in the swamp during the wet season when breeding reaches a peak.

Phragmites karka surrounded the pool and dominated the flora of the swamp. Algae were not abundant as numerous Tilapia appear to have grazed all algae from the surfaces present.

Station 2 - Agana Springs

The fauna of the spring was dominated by Tilapia mossambica and Gambusia affinis during the dry season and Bufo marinus tadpoles during the wet season. Anguilla mamorata and Clarius batrachus are probably common in the springs. Although not collected, Eleotris fusca and T. zilli are expected to be present at station 2.

The flora of the springs is dominated by the water lily Nymphae sp. Hydrilla verticulata is expected to become more abundant in the springs during the wet season when water clarity increases because of an increase in water flow from the lense which enables sufficient light to penetrate the water, allowing this benthic species to flourish.

Station 3 - Agana River

The fauna of the Agana River was dominated by *Tilapia mossambica*. *Eleotris fusca* was common at this site. *Poecilia reticulatus* was rare as only one specimen was observed at this site. Marine species, although not observed or collected at the time of sampling, frequent the Agana River downstream from the O'Brien Drive Bridge. Surprisingly, no *Bufo* toads or tadpoles were observed during the study. This species probably uses the site for breeding during the rainy season.

Algae were not abundant at station 3, however, small patches of *Spirogyra sp.* were present along the stream bank. The surface of the water, which was open during the dry season, became choked by *Eichornia*, *Pistia* and *Phargmites* as the rainy season began. Increased growth may be the result of nutrients which were washed out of the swamps as water flow increased.

N.C.S. Pool

The N.C.S. pool was sampled during November 1978. Day and night sampling was conducted. The fauna was composed of two mollusks, one arthropod and five species of fish. No floral species were collected. The numerous fish must continually graze all algae from the surfaces of rocks in the pool.

Tilapia mossambica dominates the fauna of the pool. The species is so numerous that almost all specimens observed and collected are less than 8 cm in length. The guppy, *Poecilia reticulatus* and the red swordtail *Xyphophorus helleri* are abundant and common in the pool, respectively. *Poecilia latipinna*, the black molly, appears to be a recent introduction to the pool as it was seen only on the last visit to the pool. The pool is a common release site for aquarium pets of families living at the nearby Naval communication base. The Grapsid crabs and the moringuid eel were collected at night. The presence of the eel may suggest that a connection between the ocean and the pool exists.

Fena Study Site

Preliminary water sampling from two small watersheds in the Fena Lake area was conducted in May - August 1979. The watersheds are illustrated in Figure 5 and 6. Watershed characteristics are presented in Table 4. Negotiations with the U.S. Navy for permission to study the effects of land clearing on the limnology and biology of a small watershed on Guam were concluded in November 1979. The project will be continued under a separate funding source, through the University of Guam.

RECOMMENDATIONS:

I. The study should be continued during fiscal year 1980.

II. More emphasis should be placed on studying the biology of the local freshwater species.

III. The larger and deeper rivers should be investigated with regard to future stocking programs.

IV. Watershed studies should be continued and future management programs be developed based upon the findings.

Report prepared by Clifford P. Neubauer

Literature Cited

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____________________. 1979. Local climatological data Guam, Pacific (monthly summaries). Environmental Data Service, National Climatic Center, Ashville, N.C.

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Taylor, M. H. 1978. Biological study proposed Ugum Dam site, Guam, M.I. Prepared for the U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii.

Table 2. Flora collected from the Agana Swamp, Agana Springs and Agana River.

Species	Swamp	Springs	River
IVISION CYANOPHYTA			
Nostocaceae			
Anabaena sp.	R		
Oscillatoriaceae			
Microcoleus lyngbyaceus (Kutz) Crouan			R
Oscillatoria sp.	R		R
Rivulariaceae			
Calothrix sp.	R		R
IVISION CHLOROPHYTA			
Cladophoraceae			
Cladophora sp.	R		R
Zygnemataceae			
Spirogyra sp.			C
IVISION ANTHOPHYTA			
Monocotyledon			
Araceae			
Pistia stratiotes L.			A
Gramineae			
Phragmites karka (Retz.) Trin.	A	R	A
Hydrochaitaceae			
Hydrilla verticillata (L.f.) Royle		C	C
Nymphaeaceae			
Nymphaea sp.		A	
Potederiaceae			
Eichhornia crassipes (Mart. and Zucc.)		C	A
Dicotyledon			
Compositaceae			
Mikania scandens (L.) Willd.		A	
Convolvulaceae			
Ipomoea aquatica Forsskal		C	
Onagraceae			
Ludwigia sp.		R	
Scrophulariaceae			
Limnophila indica (L.) Druce		R	

Table 3. Biomass estimates of macrofauna collected from the Inarajan River.

SPECIES	BIOMASS g/m^2 STATION I	STATION II	STATION III
Arthopod			
Crustacea			
Atya serrata Bate	-	*0.085	-
Caridina nilotica (P. Roux)	0.004	-	-
Macrobrachium lar (Fabricius)	0.27	1.09	-
Chordata			
Osteichthyes			
Anquillidae			
Anquilla mamorata (Quoy & Gaimard)	-	2.73	-
Eleotridae			
Eleotris fusca (Scheinder)	0.25	0.88	-
Gobiidae			
Awawous guamensis (Valenciennes)	0.31	-	0.2
Microsicybium elegans (Steindacher)	0.02	-	0.008
Sicyopterus macrostetholepis (Bleeker)	-	-	0.13
Kuhliidae			
Kuhlia rupestris Lacepede	15.83	23.48	6.25

*Estimate includes values for *A. serrata* and *C. nilotica*.

Table 4. Topographic characteristics of the selected study site.

	Watershed 1	Watershed 2
Area (m^2)	89,665	91,375
Area (ha)	0.90	0.91
Aspect	ENE	ENE
Elevation (m)		
Minimum	79.2	79.2
Maximum	164.6	164.6
Drainage (m)		
Length	805	773
Elevation change	85.3	85.3

Figure 1.

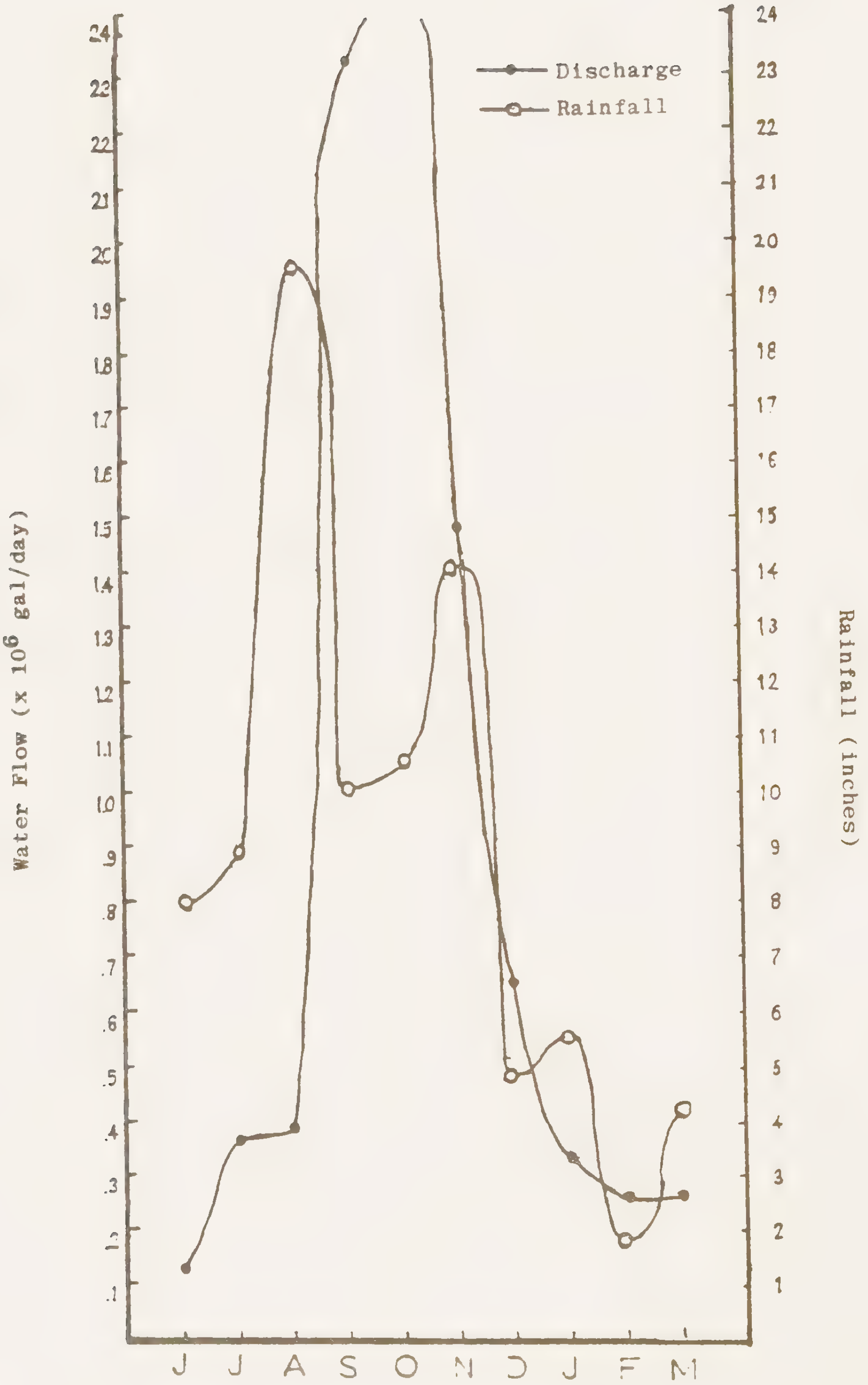


Figure 1. Monthly water flow and rainfall data from the Geus River, Guam, during fiscal year 1979.

Figure 2.

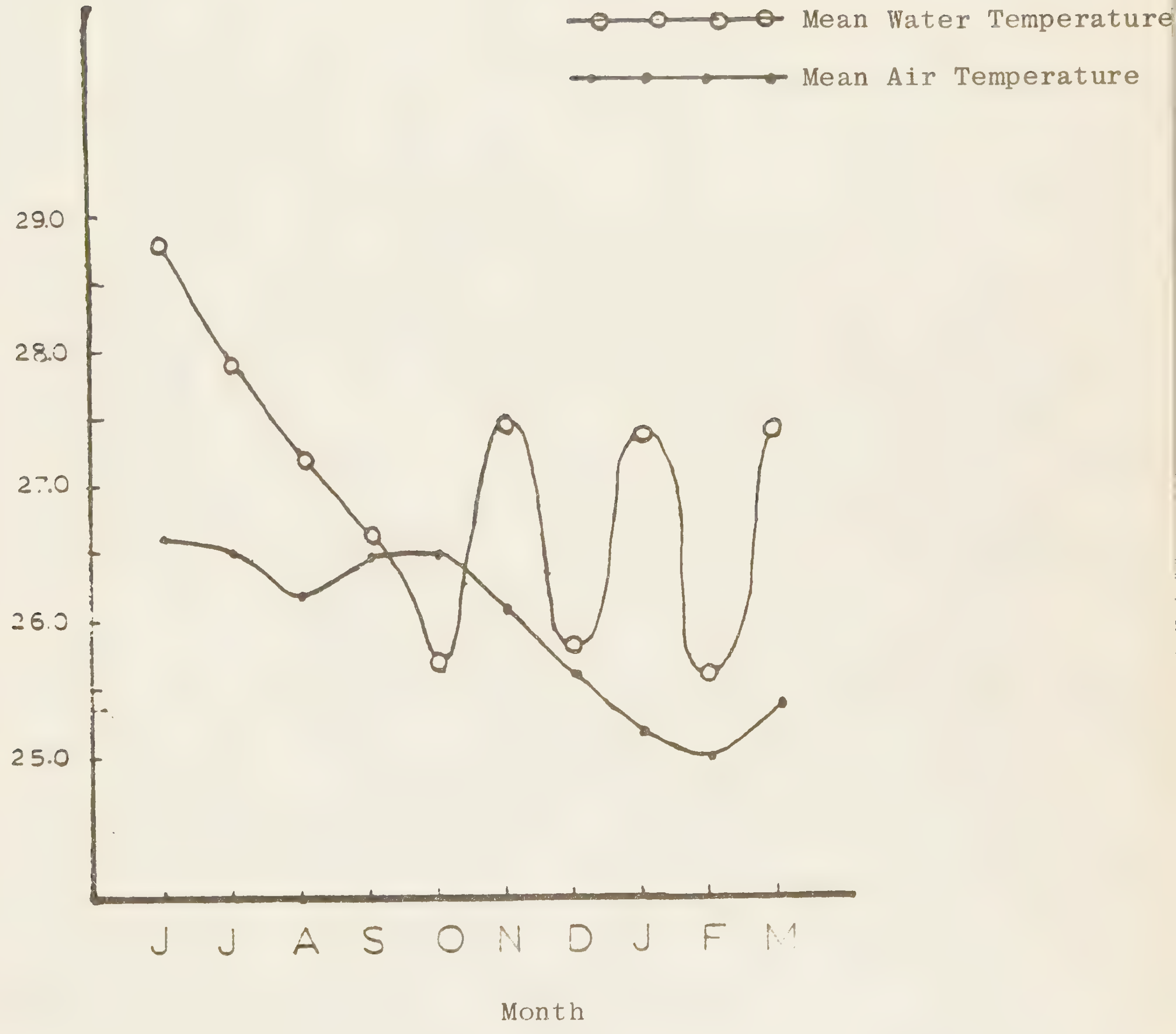
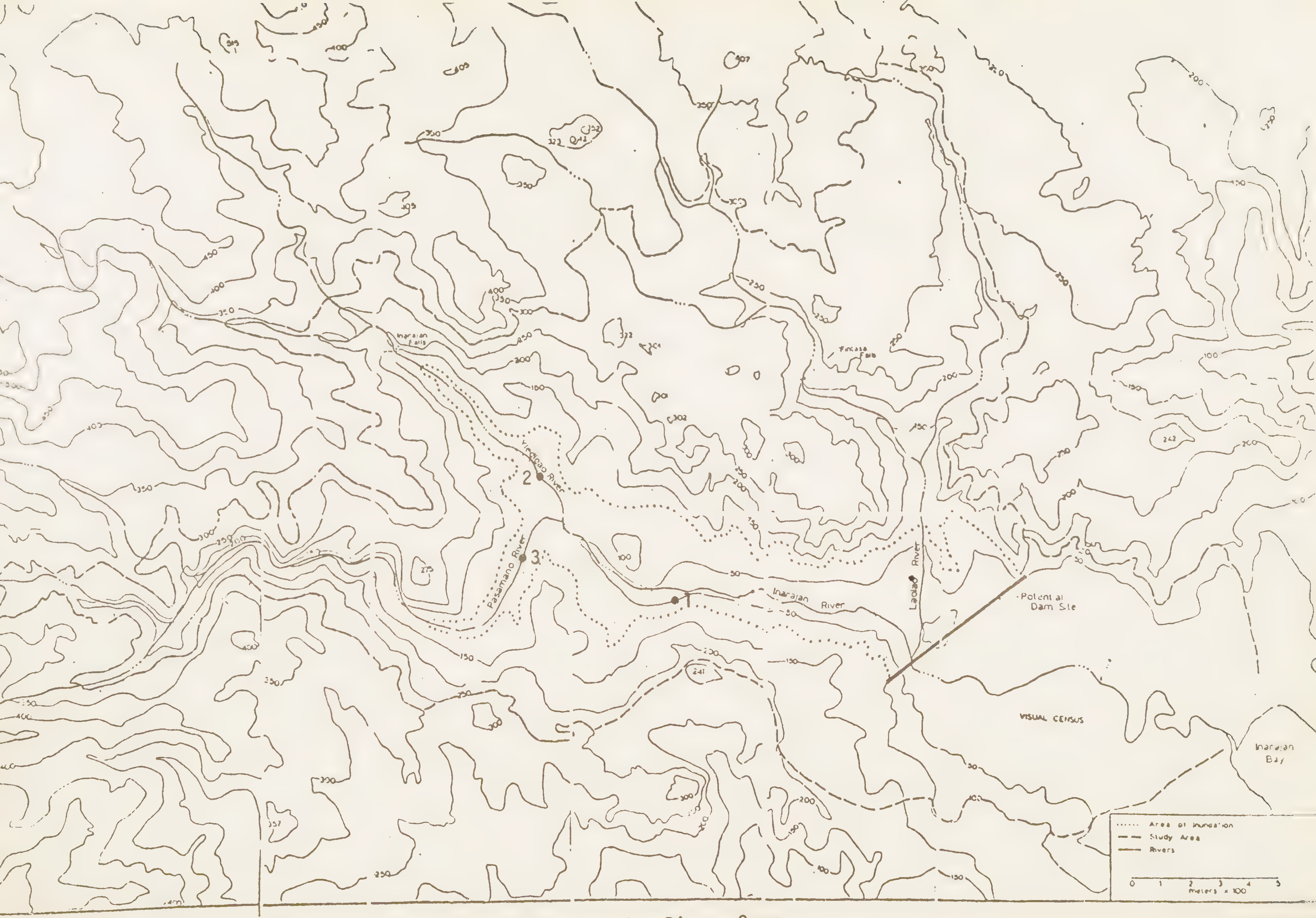
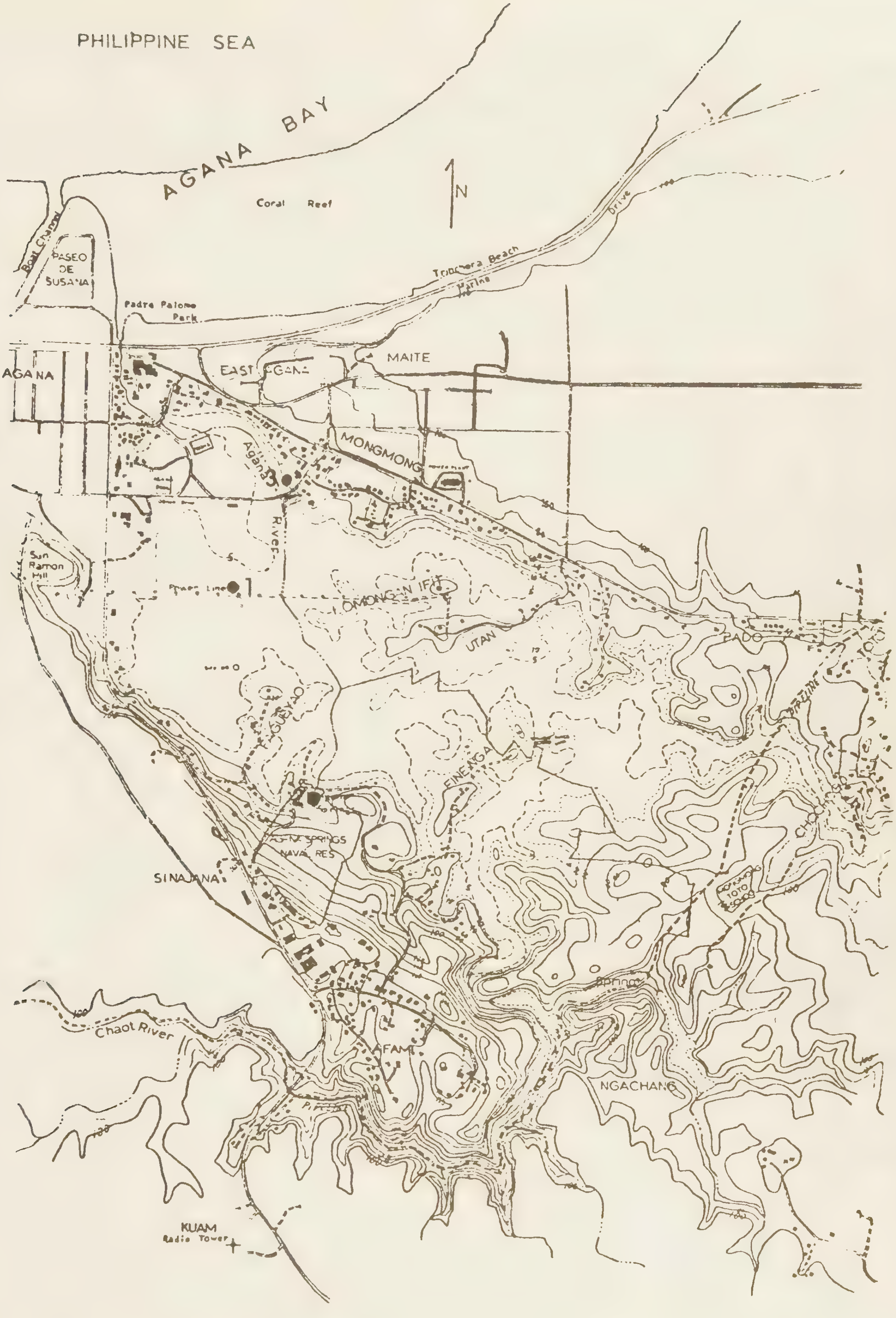


Figure 2. Mean air and water temperatures from the Geus River, Guam, during fiscal year 1979.


Inarajan Bay
Potential Dam Site
VISUAL CENSUS
Inarajan River
Laolao River
Yledigao River
Pasamano River
Inarajan Falls
Fintasa Falls
1
2
3
Area of Inundation
Study Area
Rivers
0 1 2 3 4 5
meters x 100

Collecting stations established on the Inarajan River, Guam.


PHILIPPINE SEA
AGANA BAY
Coral Reef
N
Boat Channel
PASEO DE SUSANA
Padre Palomo Park
Trinchera Beach
Marine Drive
AGANA
EAST AGANA
MAITE
MONGMONG
Agana River
3
San Ramon Hill
1
LOMONGAN IFIT
UTAN
PADO
AGUEYAO
FINENGA
2
AGANA SPRINGS NAVAL RES
SINAJANA
CHOCHOGO
TOTO
Chaot River
AFAME
NGACHANG
KUAM Radio Tower

igure 4. Collecting stations established on the Agana Swamp, Agana Springs and the Agana River, Guam. (Outline drawing from Randall and Tsuda, 1974).

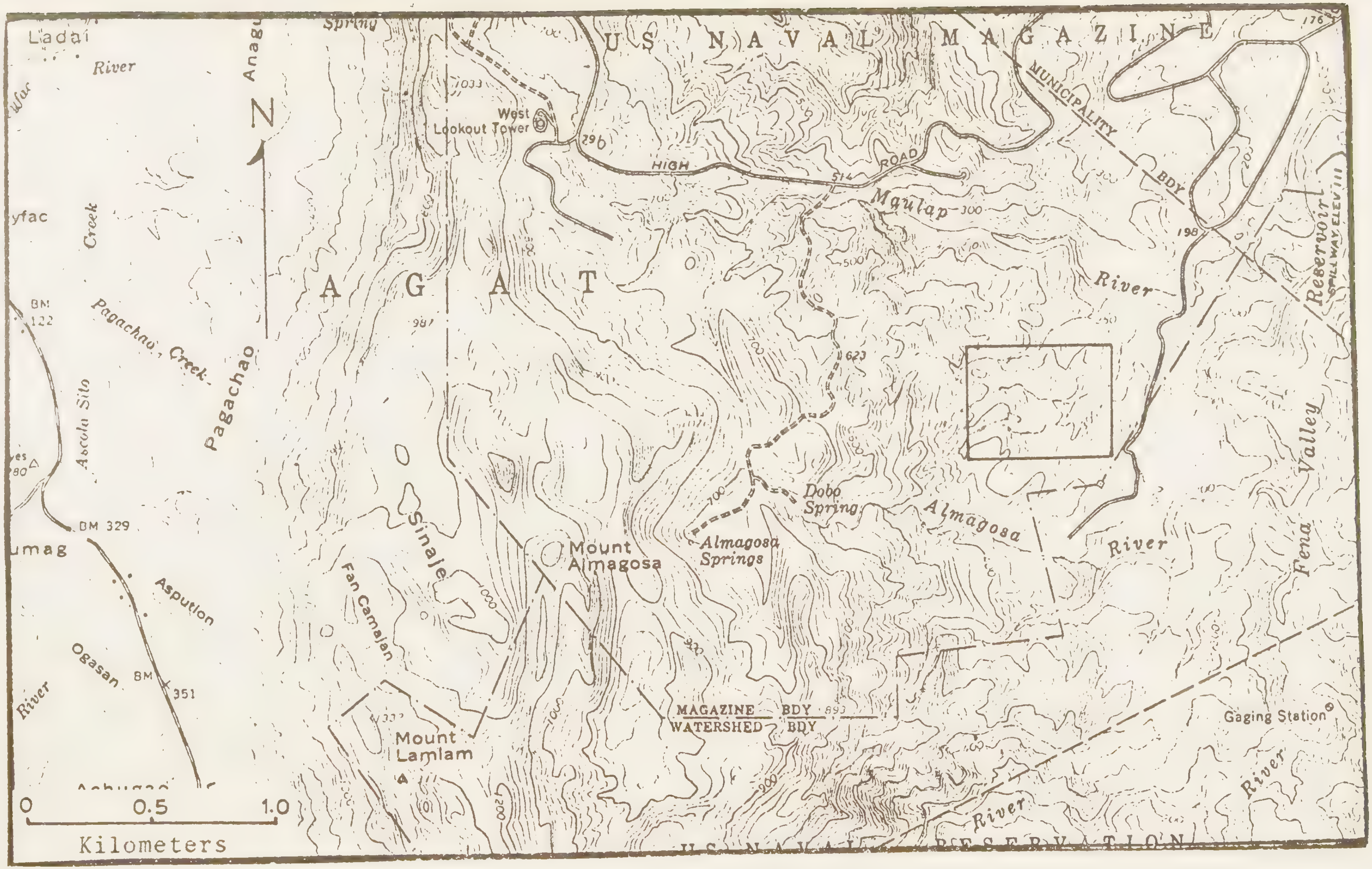

U S NAVAL MAGAZINE
MUNICIPALITY BDY
Reservoir
SPILLWAY ELEV 111
Ladai
River
Anagu
N
West
Lookout Tower
1033
296
HIGH
ROAD
514
Maulap
300
500
198
River
A G A T
yfac
Creek
BM 122
Pagachao Creek
Pagachao
Ascola Silo
987
623
700
Valley
Fena
Dobo Spring
Almagosa
Almagosa Springs
Mount Almagosa
River
Sinaje
1000
BM 329
umag
Asputlon
Fan Camalan
Ogasan
BM
351
River
Mount Lamlam
MAGAZINE BDY
WATERSHED BDY
893
Gaging Station
River
River
200
U S NAVAL RESERVATION
0
0.5
1.0
Kilometers

Figure 5. Proposed experimental watersheds shown within the small rectangle (from USGS map. Agat quadrangle, Mariana Islands-Island of Guam. 1:24,000 series (Topographic) 1968.)

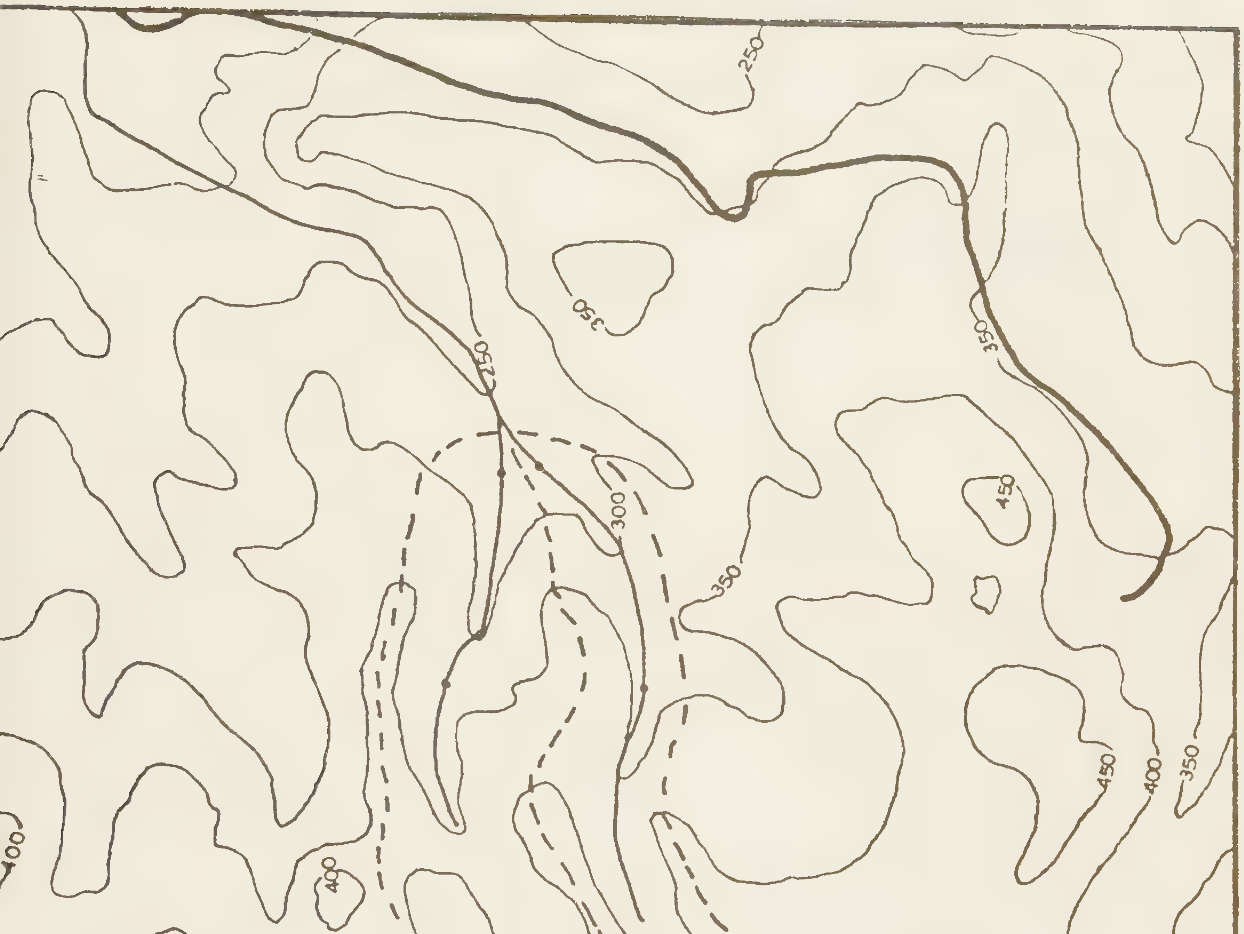

250
350
250
300
350
450
350
450
400
350
400
400
450
500
550
N
Roads
Rivers
Watershed boundary
0
100
200
Meters
600

Figure 6. Proposed experimental watersheds and collecting sites enlarged from Figure 5. (Outline drawing from General Planning Map Series, Government of Guam, Uniform Mapping System #19 of 74.)

Table 1. Fauna collected from established stations on the Inarajan River, Agana Swamp and NCS pool, Guam.

	INARAJAN	AGANA SWAMP	NCS POOL
MOLLUSCA -			
Nertina pulligera Linne	1, 2		
Mellanidae	1, 3		
Circulus sp.			
Unidentified gastropod #1		2	1
Gastropod - #2		2	1
ARTHROPODS -			
Crustacea			
Atya serrata Bate	1, 2		
Caridina nilotica (P. Roux)	1, 2		
Grabsidae			1
Macrobrachium lar (Fabricius)	1, 2		
INSECTA -			
Odonata		2	
GERRIDAE			
Limnogonos sp.		2	
HYDROPHILIDAE			
Enochrus rubrocincius (Regimbart)		2	
CHORDATA			
ANABANTIDAE			
Beta brederi Myers		2	
ANQUILLIDAE			
Anquilla mamorata Quoy and Gaimard	2		
EICHLIDAE			
Tilapia mossambica (Peters)		1, 2, 3	1
T. zilli (Geruais)		1	
CLARIIDAE			
Clarius batrachus (Linnaeus)		1, 2	
ELEOTHRIDAE			
Eleotris fusca (Schneider)	1, 2	1, 3	
GOBIIDAE			
Awaous guamensis (Valenciennes)	1, 3		
Microsicydium elegans (Steindachner)	1, 3		
Sicyopterus macrostetholepis (Bleeker)	3		
KUHLIIDAE			
Kuhlia rupestris (Lacepede)	1, 2, 3		
POECILIIDAE			
Gambusia affinis (Baird and Girard)		2	
Poecilia latipinna			1
P. reticulatus		1, 3	
Xiphophorus helleri			1
AMPHIBIA			
Bufo. marinus (Linnaeus)		1	

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT TITLE: Guam Fisheries Development

PROJECT NO.: FW-2R-16

JOB TITLE: Experiments with Moored Offshore Fish Attracting and Congregating Devices

JOB NO.: F-8

Period Covered: July 1, 1978 to September 30, 1979.

INTRODUCTION:

Guam is a tropical island of about 210 square miles located at 13^{O}N at the southern end of the Mariana Island chain. In general, the coral reefs and waters immediately surrounding tropical islands are closely analogous to oases in an oceanic desert. Low nutrient levels in oceanic waters result in correspondingly low productivity with fishes thinly scattered over wide areas. Productivity increases dramatically near islands where nutrients are subject to tight recycling back into the system. Around the island of Guam and the associated shallow bank areas, the common sport fish include migratory tunas, dolphinfish, billfish and rainbow runners, and a wide variety of resident reef fishes.

Sport fishing has a multiple significance on Guam in that it is an important tradition of the Chamorro culture, it is becoming an increasingly important tourist attraction, and it is a favorite pastime of a significant segment of the transient military and contract work force. From July 1977 to June 1978, sport fishermen fishing offshore landed an estimated 206 metric tons of fish in 20,500 man-days of effort (AWR Annual Report, 1978). These fishermen face a number of problems which may be alleviated at least partially through recent advances in fishery management procedures. The problems include: large amounts of time wasted searching for pelagic fish offshore, the inability to reach pelagic fish in unsheltered rough waters, and usually low concentrations of both pelagic and reef fish in any particular area.

This project is expected to enhance the quality of the recreational fishing experience available on Guam through increased catches and reductions in the time lost searching for fish. The specific work items involved in the project include the construction of artificial reefs in shallow water (< 200 feet), and the construction and deploying of fish attractors in both shallow and deep water. Derelict ships, discarded concrete and metallic construction materials, and other items are all suitable for constructing artificial reefs. Midwater fish attractors anchored in shallow water (100 to 200 feet) may be used to make inshore trolling lanes. And buoys moored in deep water (up to 1,000 fathoms) serve as excellent aggregating devices for pelagic fishes, especially if they are adorned with a variety materials hanging below them in the water.

PRESENT STATUS:

Artificial Reefs

A 250 foot fuel tanker, the M/V PEACE OCEAN, ran aground and was left high and dry on Gabgab Beach, Apra Harbor, in 1976 just prior to Typhoon Pamela. After that time, she deteriorated badly, especially the area of the hull along the air and water interface. This caused the Coast Guard to recognize her as a potential hazard if she should break up in a storm and dump a large quantity of oil on the reef in addition to causing physical damage. Therefore the Army Corps of Engineers initiated proceedings to claim custody of the vessel and, with the cooperation of the Navy and Coast Guard, have her removed. No bids were ever received for the vessel by the Corps, and custody was claimed.

For a year prior to the Army Corps of Engineers taking custody of the vessel, representatives of the Aquatic and Wildlife Resources Division, the U.S. Coast Guard, the U.S. Navy, the U.S. Army Corps of Engineers, the Guam Environmental Protection Agency, and the University of Guam Marine Laboratory, met on a number of occasions to decide the ultimate fate of the vessel. It was agreed by all that she would best serve the public if she were sunk in shallow water to serve as an artificial reef and supply fish habitats. A dump site was selected by AWR in 110 feet of water between Facpi Point and Anae Island, and was approved by all.

After obtaining custody of the vessel, the Corps of Engineers contracted to have all the oil removed from the ship. On 30 August 1979 she was ready to be pulled off the reef and moored in the harbor until volunteers could clean her of an extensive amount of loose debris. First she was turned so that she was lying perpendicular to the reef edge, with her bow extended past the reef into deep water. Then the holds of the bow section were flooded to raise the stern. This made it easier to pull her off completely. Trouble occurred shortly after she floated free and began to list heavily to starboard. The Coast Guard was unable to pump her out faster than she was taking on water and, instead of towing the vessel across a submarine operating area to the proposed site at Facpi Point, the PEACE OCEAN was towed straight out to sea and sunk in an authorized deep-water dump site.

Despite the set back in losing our first large ship for an artificial reef, the project will be continued as new artificial reef materials become available. Another derelict ship the M/V SLIDRE, is aground in Apra Harbor and may be the next candidate for an artificial reef.

The Aquatic and Wildlife Resources staff appreciate the effort by all concerned to cooperate in turning the PEACE OCEAN into an artificial reef.

Fish Aggregating Devices

A new project this year has been the construction of several fish aggregating devices to be moored in deep water (up to 1,000 fathoms) offshore. The devices are designed to attract and hold in their vicinity fishes such as yellowfin and skipjack tuna, and mahimahi. Similar devices have been very successful in Hawaii and elsewhere. They save the fishermen time and fuel in searching for schools of fish.

To date, three buoys have been constructed with Pacific Tuna Development Funds using the Hawaiian three 55-gallon drum design (Figures 1 and 2). The cost per buoy including the hanging gear and mooring line was approximately $3,300 (Table 1). Initially only two of the buoys will be set out, one off Facpi Point in the south and one off Haputo Point in the north (Figure 3), and the third buoy will be reserved as a replacement. A Notice to Mariners has been filed with the U.S. Coast Guard and all is ready for their installation. (The Notice to Mariners, Permits, and DEIS are found in the Appendix.) They should be in place in early December 1979, pending the availability of the Coast Guard Cutter BASSWOOD.

Inshore Trolling Lanes

No action has been taken to date to construct any inshore trolling lanes. However, several sites have been proposed, including the Agat Bay area and Tumon Bay.

The design of the lanes will consist of a series of moored midwater fish attractors in shallow water (<25 fathoms). Each attractor will be anchored in place, and the lane will be clearly identified by small surface buoys. Initially a variety of different designs of attractors will be used to test for their suitability.

RECOMMENDATIONS:

Efforts should be continued to construct artificial reefs. If no derelict ships are available for use, other materials such as concrete and construction materials should be considered. It is important that any artificial reef provide a variety of crevices and holes to shelter fish, and this should be considered in the reef design.

Aggregating devices should be deployed offshore and as trolling lanes inshore. Different designs should be tried considering the undeveloped state of the art.

Report prepared by: Henry G. Tucker and R. Logan Kock

Table 1. Expenses-Fabrication of Tuna Aggregation Devices and Anchors.

1. Direct Labor 292 hours @$12.00/hr.:		$3,504.00
2. Material and Supplies Cost:		$7,605.21
a. 5/8" polypropylene rope 5,000 fathom, CIF Guam	$3,663.84	
b. Angle Iron		
(1) 2" x 2" x ¼" x 20' x 12 pcs. @$18.30 ea.	219.60	
(2) 3" x 3" x ¼" x 20' x 2 pcs. @$23.30 ea.	46.40	
(3) 1½" x 1½" x 1/8" x 20 x 4 pcs. @$7.85 ea.	31.40	
(4) 1/8" x 1" x 20' flat bar x 1 pcs. @$2.35 ea.	2.35	
(5) Miscellaneous angle iron 36 pcs. @$.75 ea.	27.30	
	$327.25	
c. Pipe		
(1) 2" x 20' G.I. x 3 pcs. @$31.00 ea.	93.00	
(2) 1¼" x 20' G.I. x 1 pcs. @$15.40 ea.	15.40	
(3) 3/4" x 20' G.I. x 3 pcs. @$8.70 ea.	26.10	
(4) 6" x 3' tube	8.83	
	$143.33	
d. Lumber		
(1) 1" x 6" x 16' Philippine mahogoney x 16 pcs. @$2.75 ea.	$ 44.00	
e. Aluminum & Cutting		
(1) 4 reflectors	$ 79.66	
f. Nuts, bolts, washers	$ 74.81	
g. Welding Supplies		
(1) Electrodes 6011 x 1/8"	30.60	
(2) Oxygen 2 refills	26.00	
(3) Acetylene 1 refill	26.50	
	$ 83.10	
h. Paint & Aids		
(1) Rust-Mort	15.66	
(2) Zinc Chromate primer 4 gal. @$16.65 ea.	66.60	
(3) Paint 1 gal. orange 1 gal. white	30.19	
(4) Thinner	9.45	
(5) Brushes	7.86	
	$129.76	
i. Chain & Cable		
(1) 140' 5/16" galv. chain @$1.95/foot	273.00	
(2) 3/8" surplus stainless cable 500'	200.00	
	$473.00	
j. Shackles, clips, swivels, thimbles, eyes	$233.73	
k. Anchor Materials		
(1) Concrete 10 bags @$5.15	51.50	
(2) Sand 2 pickup loads @$5.00	10.00	
(3) Aggregate 1 pickup load @$5.00	5.00	
(4) Reinforceing rod & bending	90.45	
	$156.95	
l. Hanger material-donated tuna purseweb	NC	
m. Foam filling of 9 drums	$450.00	
n. Guest Corp #561/87 marker lights x 12 ea.	$631.32	
o. Miscellaneous		
(1) Gasoline, wire brushes, drill bits, saw blades, chipping hammer, soap stone	$ 39.65	
COST PER BUOY	$3,344.60	
TOTAL COST - Buoys & Anchors to Pacific Tuna Development Funds		$10,034.00

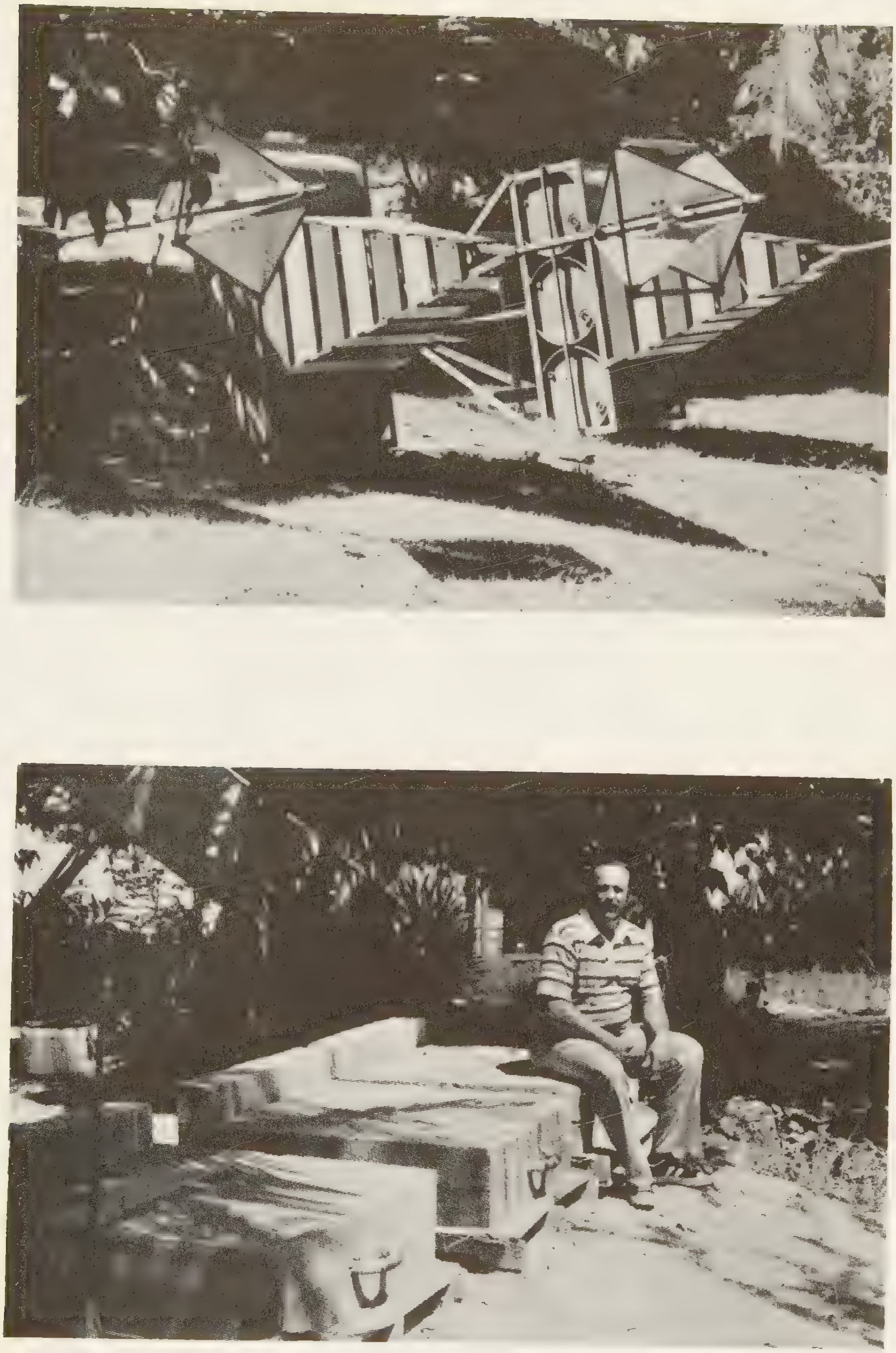


Figure 1. Aggregating buoys constructed using the Hawaiian three 55-gallon drum design. Below Rich Howell, fisheries consultant on this project, sits on the buoy's mooring blocks.

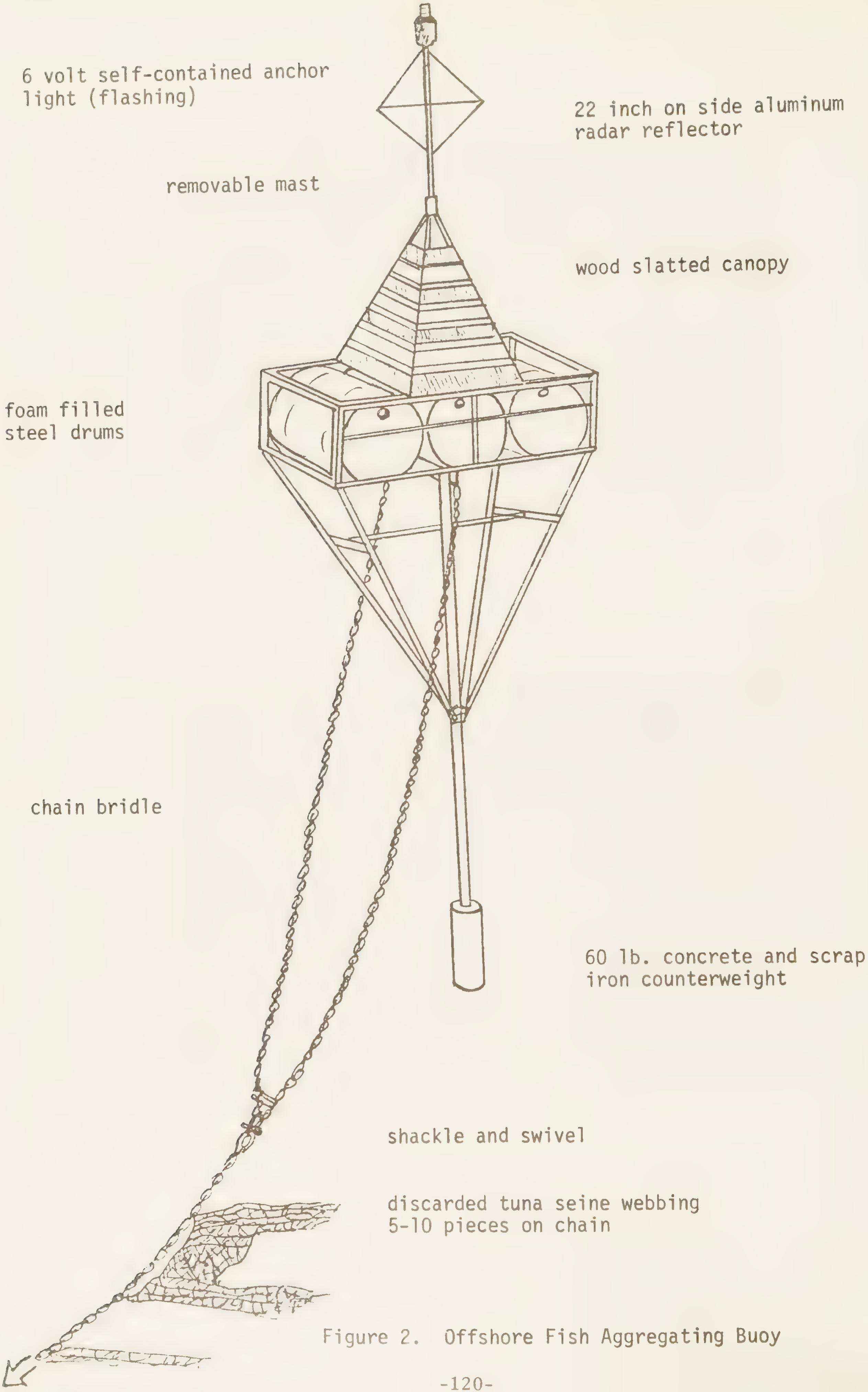

6 volt self-contained anchor light (flashing)
22 inch on side aluminum radar reflector
removable mast
wood slatted canopy
foam filled steel drums
chain bridle
60 lb. concrete and scrap iron counterweight
shackle and swivel
discarded tuna seine webbing 5-10 pieces on chain

Figure 2. Offshore Fish Aggregating Buoy

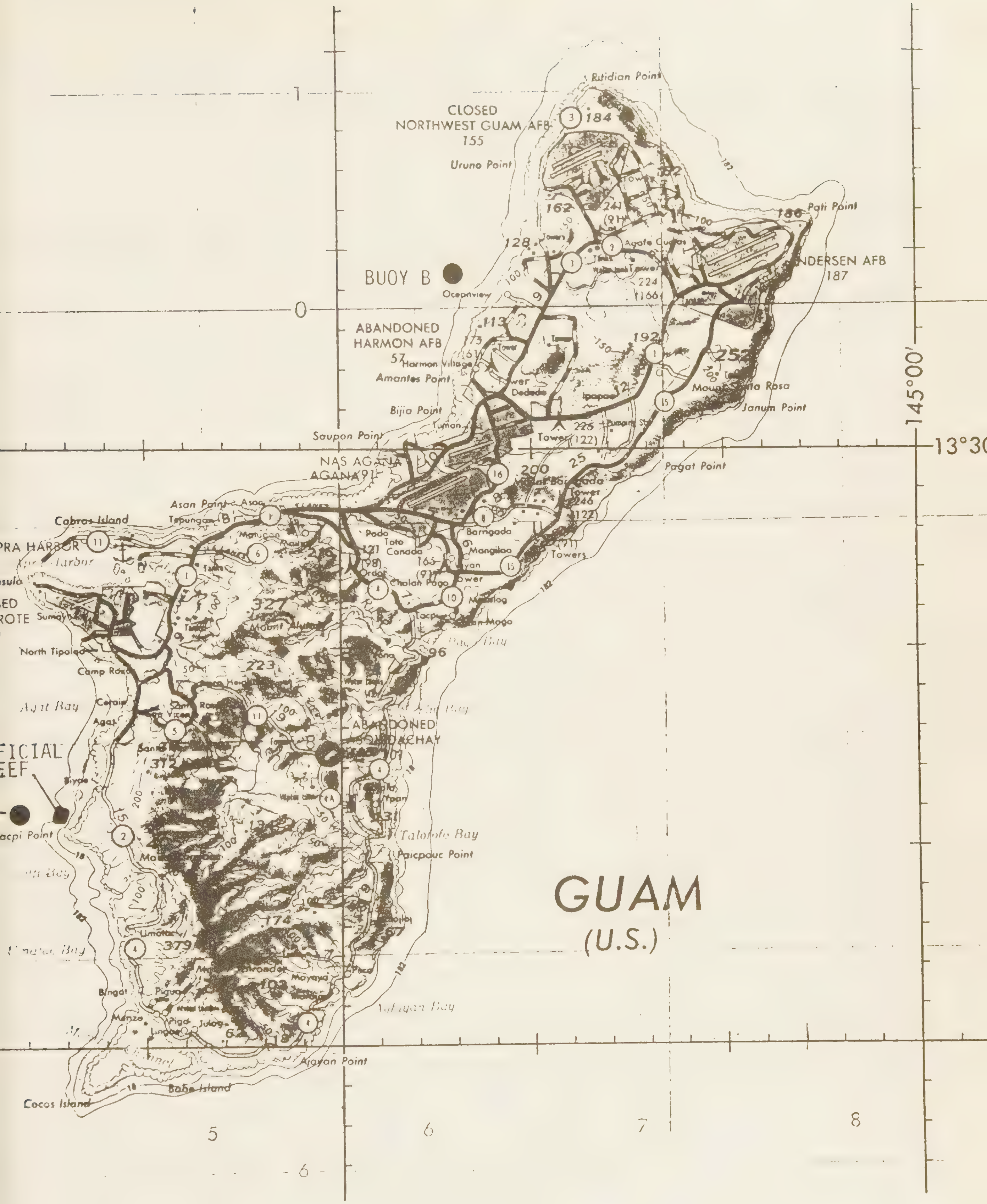

CLOSED
NORTHWEST GUAM AFB
155
Ritidian Point
Uruno Point
BUOY B
Oceanview
ABANDONED
HARMON AFB
57
Harmon Village
Amantes Point
Bijia Point
Tumon
Saupon Point
NAS AGANA
AGANA 91
Pati Point
ANDERSEN AFB
187
Mount Santa Rosa
Janum Point
Pagat Point
Asan Point
Asan
Tepungan
Cabras Island
APRA HARBOR
North Tipalao
Camp Roxas
Agat Bay
ARTIFICIAL
REEF
Facpi Point
Barrigada
Mangilao
Chalan Pago
Talofofo Bay
Paicpouc Point
ABANDONED
HADACHAY
Umatac
Merizo
Bingat
Piga
Jutog
Ajayan Point
Cocos Island
Babe Island
Pago Bay
GUAM
(U.S.)
145°00'
13°30'
1
0
5
6
7
8
- 6 -

Figure 3. Map of Guam showing buoy sites and proposed site of the large ship artificial reef.

APPENDIX

CONTENTS

A. Draft Environmental Impact Assessment for Fish Aggregating Buoys

B. Army Corps of Engineers Permit

Environmental Impact Assessment for Fish Aggregating Buoys

Project Description

This project will result in the anchoring of fish aggregating buoys at five or six locations in the offshore waters around Guam. These buoys and the objects suspended from them will attract pelagic fishes and provide better fishing for the fishermen of Guam. These buoys will be held in place with a 2,000 pound anchor. Water depths will vary from 250-870 fathoms depending on the location The anchor line will be 5/8 inch polypropylene rope with lenghts of chain 50 feet long connecting the rope to the anchor and to the buoy. The buoy will be constructed of three 55 gallon drums filled with polyeurethane foam. These drums will be enclosed side by side in a frame of angle iron. A four-foot high canopy built of angle iron and plywood will house the battery that provides power to the flashing marine warning light at the top of a ten-foot long pole. A radar reflector will be attached to the pole below the light. Fish aggregating objects will be attached to the buoy and suspended 40-100 feet into the water. The type of materials to be used will be subject to what is available. Possible choices are old fish nets of large mesh size and burlap bags or palm fronds tied to polypropylene or manila rope.

The coordinates for the possible anchorages are listed in

Table I and are indicated on the attached maps. Specific sites will be selected from those locations which are approved by the U.S. Coast Guard.

The purpose of the fish aggregating buoys is to concentrate pelagic fishes around one location, thus aiding local fisherman in finding and catching these fishes. The ability of floating objects to attract fish has long been known by fisherman of the Pacific Basin, and simple fish aggregating devices have been utilized by them. More recently, the National Marine Fisheries Service in Hawaii has employed fish aggregating buoys with great success and our device is modeled after theirs.

Environmental Setting Without The Project

Fish aggregating buoys will be anchored in deep water away from the coral reefs of Guam, posing no threat to them. The nature of the bottom is unknown for the locations indicated. In general, the deep waters around Guam are composed of hard substrate or unconsolidated calcium carbonate and volcanic sediments. Shrimps (*Heterocarpus ensifer* and *H. laevigatus*) are abundant in waters up to 400 fathoms deep, and eels (Family Congridae), gorgonians, crabs, sea urchins and other benthic organisms are also found in deep water. In general, little is known of the specific deep water benthic organisms around Guam and their general abundance.

The oceanic water around Guam has very few nutrients, and a low biological productivity. The small numbers of phytoplankton and zooplankton results in clear, blue water surrounding the island. Except in localized areas close to shore (eg. sewer outfalls), the water is pristine and pollution free.

Environmental Impact Of The Proposed Project

The environmental impact of the fish aggregating buoys will be minimal and primarily of a positive nature. The anchor will cover a small portion (approximately nine square feet) of the bottom but in turn provide a hard substrate for colonization or shelter. The buoy will be a substrate for shallow water benthic organisms and offer shelter to small fishes, factors which probably contribute to the buoys ability to attract the larger pelagic fishes.

The maximum lifetime of one fish aggregating buoy will be two years. If the buoys are successful, based on a increased catch by local fishermen, they will be replaced at the same location. If success is limited, the replacement fish aggregating buoy may be moved to another approved location. The anchor and chain of old aggregating devices will be left on the ocean floor.

Every year, Guam has tropical storms and typhoons passing through the area which could damage the buoy or break the mooring line. When a buoy is lost in a storm, it will be replaced as soon as possible.

Alternatives to the Proposed Action

The only alternative to the proposed action is to abandon the project. Because aggregating buoys are very affective in concentrating pelagic fishes, their placement around Guam will result in larger catches by the fisherman of Guam, and in turn provide more fresh fish to be sold at local markets. Knowing there are usually fish around the buoys should provide a positive impetus to the charter boat, commercial and sport fishermen of Guam. The potentially positive impact to the Guam community of anchoring offshore fish aggregating buoys offsets any minimal negative impact, and abandoning the project does not appear justifiable.

Additional Information

No known objections to this project have been voiced by local organizations. Local fisherman are enthusiastic about the project, and at one point the Guam Fishing and Boating Association had considered installing a similar aggregating buoy at it's own expense.

TABLE I: Coordinates and depths of the locations within 3 miles of shore to be utilized as possible sites for fish aggregating buoys.

1)	13°30.4'N	144° 37.6'E	600 fathoms
~~2)~~	13°28.8'N	144° 37.2'E	520 fathoms
3)	13°28.1'N	144° 35.7'E	600 fathoms
~~4)~~	13°25.0'N	144° 35.3'E	870 fathoms
5)	13°23.4'N	144° 35.7'E	670 fathoms
6)	13°20.2'N	144° 36.4'E	570 fathoms
7)	13°14.0'N	144° 37.4'E	400 fathoms
8)	13°13.1'N	144° 37.1'E	570 fathoms
9)	13°12.8'N	144° 38.0'E	400 fathoms

N33:lr
11011
Ser 1218
1 NOV 1979

From: Commander U. S. Naval Forces, Marianas/Commander U. S. Naval Base, Guam
To: District Engineer, U. S. Army Engineer District, Bldg. 230, Ft. Shafter, Honolulu, Hawaii 96858

Subj: Fish Aggregating Buoys off Guam, File No. PODCO-O 1514-S

Ref: (a) COMNAVMARIANAS/COMNAVBASE GUAM ltr N33:lr 11011 ser 0802 of 26 Jul 79

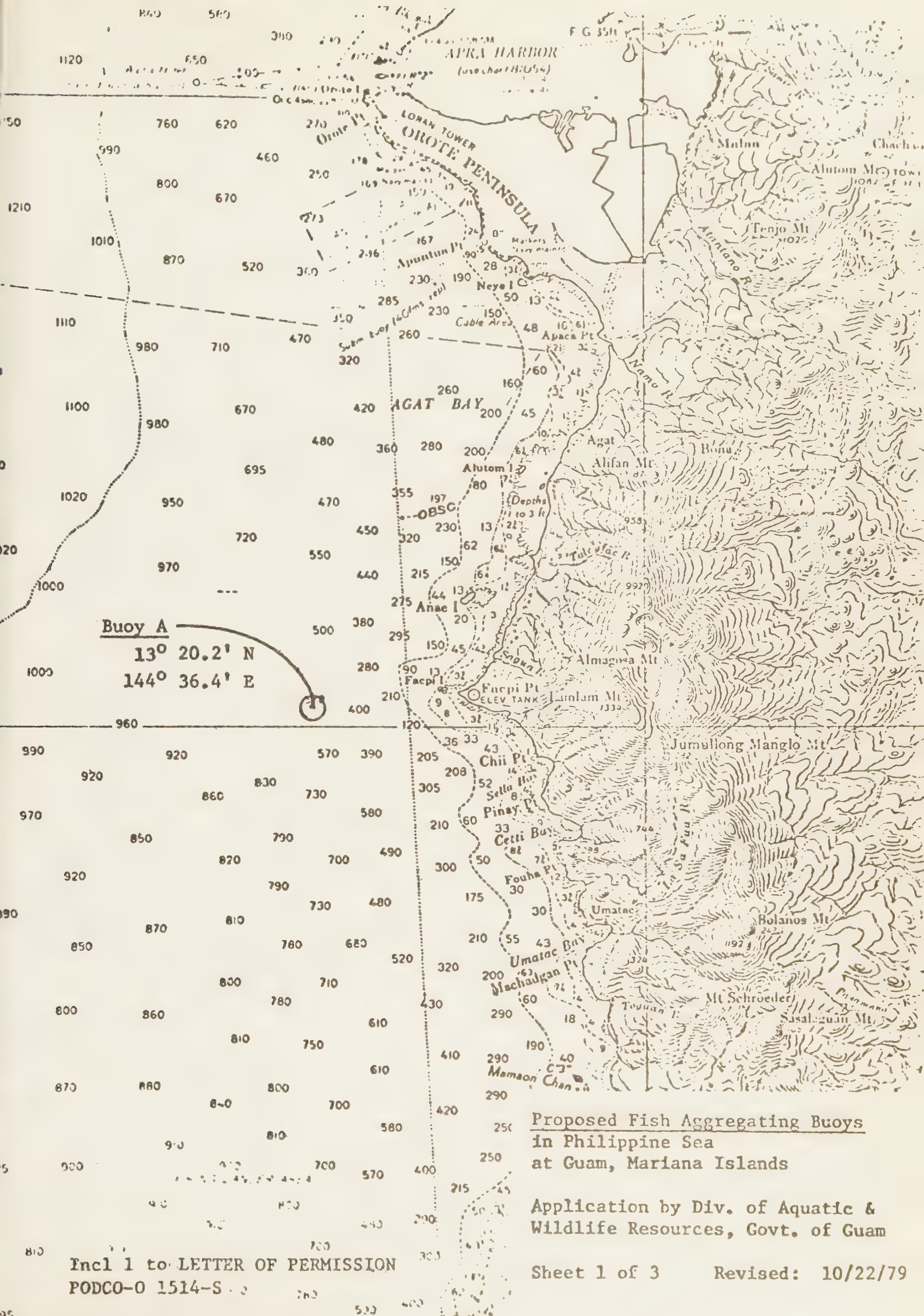
1. Reference (a) forwarded comments on some twenty proposed locations for fish aggregating buoys in offshore waters around Guam. The majority of those coordinates were determined to be objectionable due to interference with submerged approach and departure of vessels together with other local surface and subsurface operations.

2. Recent liaison with Government of Guam, Division of Aquatic and Wildlife Resources, has indicated that their desire is to activate only two sites at this time. Approaching the problem from the approximate area and depth of water desired for the buoys, the following two locations (redesignated sites A and B) have been derived which are satisfactory to both the Division of Aquatic and Wildlife Resources and local Navy commands:

Buoy A	13-20.2N, 144-36.4E
Buoy B	13-35.1N, 144-47.8E

M. L. DUKE
Chief of Staff

Copy to:
GOVGUAM, DIV of Aquatic & Wildlife Resources
COMCOGARD MARSEC GUAM
COMSUBRON FIFTEEN (w/ref)



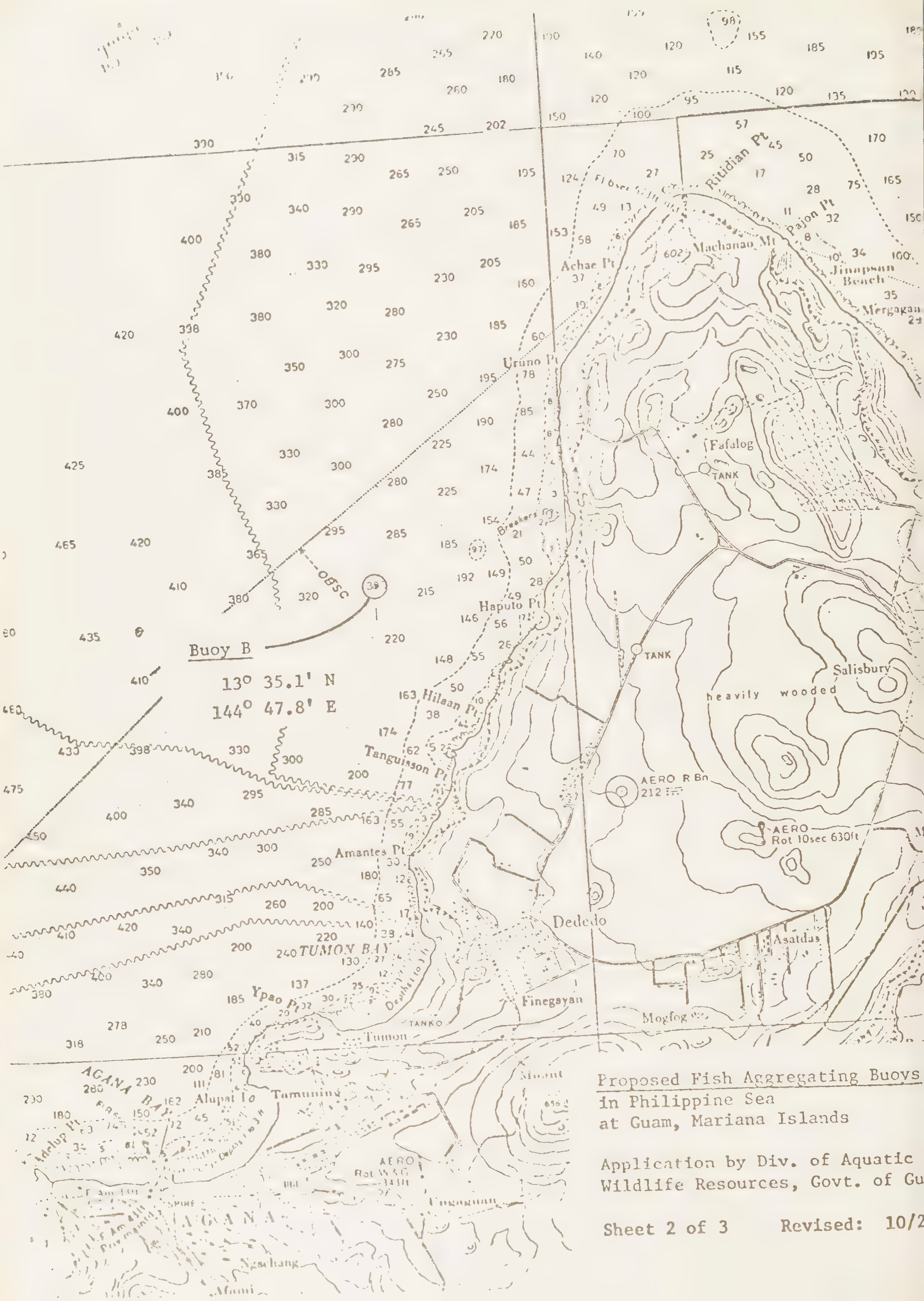
Buoy A
13° 20.2' N
144° 36.4' E
APRA HARBOR
Orote Pt
OROTE PENINSULA
LORAN TOWER
Apuntun Pt
Neye I
Cable Area
Apaca Pt
AGAT BAY
Alutom I
Anae I
Facpi I
Facpi Pt
ELEV TANK
Chii Pt
Sella Bay
Pinay Pt
Cetti Bay
Fouha Pt
Umatac Bay
Machadgan Pt
Mamaon Chan
Agat
Alifan Mt
Almagosa Mt
Lamlam Mt
Jumullong Manglo Mt
Umatac
Bolanos Mt
Mt Schroeder
Sasalaguan Mt
Malon
Alutom Mt
Tenjo Mt
Namo R
Talofofo R
Bona
Toguan R
Sella R

Proposed Fish Aggregating Buoys
in Philippine Sea
at Guam, Mariana Islands

Application by Div. of Aquatic &
Wildlife Resources, Govt. of Guam

Sheet 1 of 3 Revised: 10/22/79

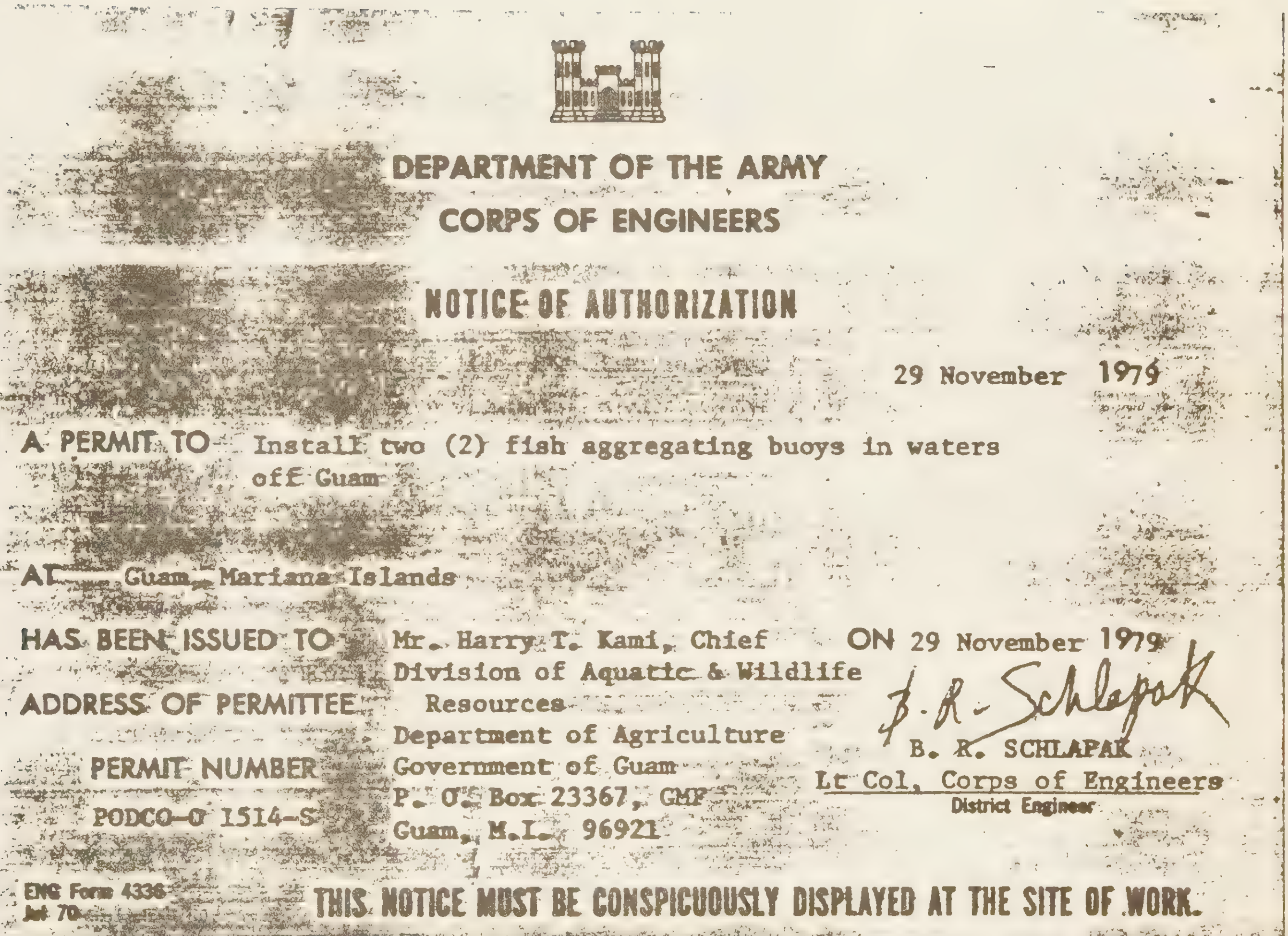
Incl 1 to LETTER OF PERMISSION
PODCO-O 1514-S


Buoy B
13° 35.1' N
144° 47.8' E
OBSC
Ritidian Pt
Pajon Pt
Machanao Mt
Jinapsan Beach
Mergagan
Achae Pt
Uruno Pt
Fafalog
TANK
Breakers
Haputo Pt
Hilaan Pt
Tanguisson Pt
Amantes Pt
TUMON BAY
Ypao Pt
Tumon
TANKO
heavily wooded
Salisbury
AERO R Bn 212
AERO Rot 10sec 630ft
Dededo
Asatdas
Finegayan
Mogfog
AGANA BAY
Adelup Pt
Alupat Is
Tamuning
AERO Rot W&G
Mount
AGANA
SPIRE
Ngachang
Mongmong

Proposed Fish Aggregating Buoys
in Philippine Sea
at Guam, Mariana Islands

Application by Div. of Aquatic
Wildlife Resources, Govt. of Gu

Sheet 2 of 3 Revised: 10/2



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

NOTICE OF AUTHORIZATION

29 November 1979

A PERMIT TO Install two (2) fish aggregating buoys in waters off Guam

AT Guam, Mariana Islands

HAS BEEN ISSUED TO Mr. Harry T. Kami, Chief ON 29 November 1979

ADDRESS OF PERMITTEE
Division of Aquatic & Wildlife Resources
Department of Agriculture
Government of Guam
P. O. Box 23367, GMF
Guam, M.I. 96921

PERMIT NUMBER PODCO-O 1514-S

B. R. Schlapak
B. R. SCHLAPAK
Lt Col, Corps of Engineers
District Engineer

ENG Form 4336
Jul 70

THIS NOTICE MUST BE CONSPICUOUSLY DISPLAYED AT THE SITE OF WORK.

Section II

Guam Fish Investigations
(Miscellaneous Funds)

PROJECT TITLE: National Marine Recreational Fishery Survey

PERIOD COVERED: December 1978 to 31 October 1979

FUNDING SOURCE: National Marine Fisheries Service through Survey and Marketing Services Inc.

INTRODUCTION:

In March 1978 the Department of Agriculture was informed that the National Marine Fisheries Service (NMFS) was planning a series of annual marine recreational fishery surveys to obtain data on participation, catch and effort for finfish and selected species of shellfish. Local governments were guaranteed the "right of first refusal" to participate in the survey. A Honolulu-based company, Survey and Marketing Services Inc. (SMS), won the Pacific area contract for Hawaii, Guam and American Samoa, and in turn subcontracted the Aquatic and Wildlife Resources Division (AWR) to conduct all work on Guam. Work was actually begun in December 1978, although the contract was not finally approved until 22 February 1979.

The conditions agreed to in the contract stipulated that 1,867 fisherman interviews be completed by AWR staff by 31 October 1979 (1,667 interviews required by NMFS and an additional 200 offshore interviews on funding provided by WPRFMC). AWR staff were also to supervise interviewers hired directly by SMS to collect approximately 2,400 household and telephone interviews. In return, SMS was to supply all forms and instruments necessary, initial interviewer training, one half-time biologist, and $6,300.00 to support the project.

PROJECT IMPLEMENTATION:

SMS creel censuses were conducted concurrently with regularly scheduled AWR creel censuses throughout the project. Household interviews were conducted during a pre-selected 2-week period once every two months. All completed interview forms were sent directly to SMS for processing.

The offshore (boat) creel censuses were conducted four times a month at the Agana Boat Basin and twice a month at the Merizo pier. As much as possible, all fishermen were interviewed upon returning from fishing and their catches were recorded. Inshore creel censuses were conducted along 3 established inshore routes twice each month. Inshore interviews were usually conducted before the fisherman had finished fishing for the day. An example of the interview form is included in Appendix A.

There were few problems in getting the offshore fishermen to cooperate in supplying the additional information required on the SMS forms. AWR staff have been conducting creel censuses on a regular basis for years and have built up a good rapport with most of the regular fishermen. At no time have interviewers attempted to coerce unwilling fishermen into cooperating with the survey. Occasionally a fisherman will refuse to answer because he is in a rush, but overall their cooperation has been exceptional.

Inshore interviews have presented special problems. Although we have been conducting inshore creel censuses for years as well, most fishermen are not encountered on a regular basis and are not as familiar with the program. There is more distrust (interviewers are often accused of being game wardens or tax investigators), and fishermen do not always appreciate being interviewed while they are fishing.

While there are few problems identifying catches and weighing and measuring fish caught offshore in boats, these are special problems inshore. A dozen species account for most of the offshore catch. Inshore, a single gill or surround netter may catch several dozen species at one time (there are over 600 species recorded from our reefs). Surround netters are usually interviewed on the reef several hundred yards from shore. Their fish are on stringers and not available to be individually weighed and measured. The same problem is common with spear fishermen. Cast netters and gill netters often catch large quantities of very small fish, fish too small to weigh individually on our scales. Hook and line fishermen on the reef often keep their catch in bags or baskets on their belt and do not want to be troubled with removing them to be measured. All these problems result in a considerable number of refusals on creel census forms.

There were few problems getting household interviews. The biggest problem was in the high turnover of interviewers. Two of the original four interviewers remain, but the other two left during the summer. One of the replacement interviewers hired in August never completed any interviews and caused us to completely miss the southern end of the island (about 40 interviews) for that period. Currently there are only three household interviewers on the staff, but they are handling the work quite well.

RESULTS:

From December to October, a total of 1,922 creel census interviews (1,020 inshore and 902 offshore) and about 2,360 household interviews were completed. To date there has been no return on the interviews in terms of analysis and output from NMFS. However, we expect a report on the first year's work should be forthcoming sometime in 1980.

CURRENT STATUS:

The original contract has been extended two months through December 1979 by mutual agreement, at an additional cost of $2,667 to SMS. SMS has bid on the NMFS contract for 1980, and we fully expect to continue the program with them. The new contract conditions will not require SMS to hire a creel census biologist for AWR, however the cost to SMS for a year's work will be increased to approximately $16,000. These new conditions have been mutually agreed to but remain subject to change.

Report prepared by: Henry G. Tucker

APPENDIX A
NATIONAL MARINE RECREATIONAL FISHERY SURVEY

Contents

A. Finfish Intercept Form for conducting fisherman interviews.

FINFISH INTERCEPT FORM

COMMERCIAL LICENSE
Yes
No

1 2 (1-2)

1. Interviewer code . . . . 2 ☐ ☐ ☐ (3-6)
2. Year/month/day . . . ☐☐ ☐☐ ☐☐ (7-12)
3. Interview number . . . . ☐☐☐ (13-15)
4. Hour . . . . ☐☐☐☐ (16-19)
5. State 5 9 (20-21)
6. County 0 0 1 (22-24)
7. Site code . . . . ☐☐☐ (25-27)

This study is being conducted in accordance with the Privacy Act of 1974. You are not required to answer any question that you consider to be an invasion of your privacy. I have a copy of the Privacy Act Statement which you may look at if you like.

8. Language of respondent . . . . ☐☐ (28-29)

English = 01 Filipino = 07 Chamarro = 13
Spanish = 02 Korean = 08 Samoan = 14
French = 03 American Indian = 09
Italian = 04 Native Alaskan (Eskimo, Aleut) = 10
Japanese = 05 Other (specify: ____________) = 11
Chinese = 06 Unknown = 12

9. Sex of respondent . . . . ☐ (30)

Male = 1 Unknown = 3
Female = 2

10. Estimate of mode of fishing . . . . ☐ (31)

Pier, dock = 1
Jetty, breakwater, breachway = 2
Bridge, causeway = 3
Other man-made structure = 4
Beach or bank = 5
Partyboat = 6
Charter boat = 7
Private or rental boat = 8

11. Interview status . . . . ☐ (32)

Agrees to interview = 1
Refuses interview initially = 2
Nonresponse due to language barrier, age, or other = 3
Refuses interview after start—questionnaire not usable = 4

Would you say you were fishing from . . . ☐ (33)

. . . a pier, a dock, a bridge, a jetty, a breakwater, a breachway, or a causeway?
. . . a beach, a bank, rocks or some other shore area?
. . . a boat? If Boat, ask: Was that a partyboat, a charter boat, a rental boat, or a private boat?

Pier, dock = 1
Jetty, breakwater, breachway = 2
Bridge, causeway = 3
Other man-made structure = 4
Beach or bank = 5
Partyboat = 6
Charter boat = 7
Private or rental boat = 8

13. Did you do any other (specify mode) fishing today besides here? ☐☐ (34-35)

If No, Code 01. If Yes, ask: At how many places, including here, did you (specify mode) fish today?

14. Were you fishing for anything in particular today? . . . ______ ☐☐☐☐☐☐☐☐☐☐ (36-45)

If No, Code 0 in all blocks. ______ ☐☐☐☐☐☐☐☐☐☐ (46-55)

If Yes, ask: What species? ______ ☐☐☐☐☐☐☐☐☐☐ (56-65)

15. Would you say that most of your (specify mode) fishing effort today was in the ocean, a sound, a river or bay? ☐ (66)

Ocean = 1
Sound = 2
River = 3
Bay = 4
Other (specify:__________) = 5
Don't know = 6
Refusal = 9

15 a. If *not* ocean, Code 0. If Ocean, ask: Was that more than three miles or three miles or less from shore? ☐ (67)

More than three miles = 1
Three miles or less = 2
Don't know = 3
Refusal = 9

16. If mode is *not* boat, Code the State of intercept.
If mode is Boat, ask: In what state's waters was most of your (specify mode) fishing effort? 5 9 (68-69)

Don't know = 98
Refusal = 99

17. Have you been fishing here today primarily with a hook and line? . . . . ☐☐ *(70-71)*

If Yes, Code 01. If No, ask: What type of fishing have you been doing?

Dip net = 02
Cast net = 03
Gill net = 04
Seine = 05
Trawl = 06
Trap = 07
Spear = 08
Hand = 09
Other (specify: ________) = 10
Refusal = 99

18. How many __(specify gear)__ have you been using? . . . . ☐☐ *(72-73)*

19. To the nearest half hour, how many hours have you spent __(specify mode)__ fishing today with your __(specify gear)__ in the water? . . . . ☐☐.☐ *(74-77)*

20. If complete trip, Code 00.0.
If incomplete trip, ask: How many additional hours do you expect to __(specify mode)__ fish today? . . . . ☐☐.☐ *(78-81)*

21. Not counting today, within the past 12 months how many days have you gone saltwater sport finfishing in this state? . . . . ☐☐☐ *(82-84)*

22. Not counting today, within the past 2 months how many days have you gone saltwater sport finfishing from this state? . . . . ☐☐ *(85-86)*

23. Now I'd like to ask you about your finfishing from other states. How many days have you been saltwater sport finfishing in the past 12 months from other states? . . . . ☐☐☐ *(87-89)*

24. Within the past 2 months, how many days have you gone saltwater sport finfishing from other states? . . . . ☐☐ *(90-91)*

26. Not counting gas for your car, how much would you estimate it has cost *you* to fish here today? Here is a list of expenses fishermen often have. Hand respondent expense card. . . . . ☐☐☐☐☐.☐☐ *(96-102*

Under 5 years = 01
5 to 13 = 02
14 to 17 = 03
18 to 24 = 04
25 to 34 = 05
35 to 44 = 06
45 to 54 = 07
55 to 64 = 08
65 and over = 09
Refusal = 99

28. What is your county and state of residence? . . . . ____________ County ☐☐☐ *(105-107)*

____________ State ☐☐ *(108-109)*

If county is unknown, ask: What city or town do you live in? ____________________

29. Yes or no, do you have a home telephone? . . . . ☐ *(110)*

Yes = 1
No = 2
Refusal = 9

In tlie event that my supervisor wishes to verify that I have been conducting interviewers here today . . .

If the person has an available phone: Would you be willing to give me your name and phone number so that he might contact you?

Name: ______________________________

Phone Number ______________________________ (If not home telephone, specify: ____________)
Area Code

If the person does not have a phone or refuses to answer question 29, or refuses to give phone number:

Would you be willing to give me your name and address so that he might contact you?

Name ______________________________

Address ______________________________

____
ZIP Code

30. Did you catch any fish while you were (specify mode) fishing today that I might be able to look at? . . . . ☐ *(111)*

Yes = 1 No = 2

30a. If Yes, and this person's available catch is on someone else's form, Code 00. ☐☐ *(112-113)*

If No, Code 00

If Yes, and this person's available catch is *not* on someone else's form, ask:

Did you catch all of these yourself, or did someone else catch some of these?

If someone else, ask: Can you separate out your individual catch?

If No, ask: How many fishermen including yourself have their catch here? Please don't include anyone who did not catch anything. Only count those people who have their catch here.

31. Number of Type 2 records on Page 6. . . . . ☐☐ *(114-11*

32. Number of Type 3 records on Page 7, or, if this person's available catch is on someone else's form, Code 000. . . . . ☐☐☐ *(116-11*

33. Is there a Type 4 record, that is, is this person's available catch on someone else's form? If No, Code 0. If Yes, Code 1. ☐ *(119)*

If No, skip to Item 35.   If Yes, fill out the following table by asking the following:

34a. Can you give me the names of the species you caught that are *not* here with you?

____

____

34b. What did you do with the (specify species) that you caught?

Thrown back alive = 1	Used for bait = 4	Filleted and cleaned = 7
Thrown back dead = 2	Sold = 5	Other (Specify:____________) = 8
Given away = 3	Not in vicinity of interview site = 6	Refusal = 9

34c. How many (species) did you (disposition) ?

Repeat 34b and 34c until all unavailable species are accounted for.

	Species		Species Code	Disposition	No. of Fish	
1.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
2.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
3.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
4.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
5.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
6.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
7.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
8.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
9.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*
10.		2	☐☐☐☐☐☐☐☐☐☐	☐	☐☐☐	*(1-15)*

Enter number of Type 2 Records in Item 31, Page 5

35. If the available catch for this fisherman has already been recorded on someone else's form, enter the interview code number of that person's form.

4 (1-14)

If the available catch for this fisherman has *not* been recorded on someone else's form, ask to see the catch and complete the following table:

	Species Name		Species Code	Total No.	Length	Weight	
1.		3				.	(1-23)
2.		3				.	(1-23)
3.		3				.	(1-23)
4.		3				.	(1-23)
5.		3				.	(1-23)
6.		3				.	(1-23)
7.		3				.	(1-23)
8.		3				.	(1-23)
9.		3				.	(1-23)
10.		3				.	(1-23)

Enter number of Type 3 Records in Item 32, and complete Item 33, Page 5.

PROJECT TITLE: Third Annual Marianas Fishing Derby

PERIOD COVERED: July 20-22, 1979

INTRODUCTION:

This year the Third Annual Marianas Fishing Derby (MFD) was organized and run by the Guam Fishing and Boating Association (GFBA). A check-out/check-in station was established next to the scales at the Agana Boat Basin. During the contest hours this station was occupied by volunteers from GBFA, as well as fishery biologists from Aquatic and Wildlife Resources (AWR) and Mr. Heeny S.H. Yuen who was a visiting observer from the National Marine Fisheries Services (NMFS) Honolulu Laboratory. Prizes were offered for the first, second, and third largest fish in the following categories: marlin (the blue marlin, *Makaira nigricans*, is the dominant istiophorid found in Guam's waters), yellowfin tuna (*Thunnus albacares*), mahimahi (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*); and for the largest total 3-day catch (in numbers of fish) of those four species. Fishing was open from 0500 to 2100 on 20 and 21 July, and from 0500 to 1700 on 22 July. There were no restrictions on the number of fishermen or lines per boat, nor on the areas fished, as long as boats did not leave the boat basin before 0500 and returned to the boat basin by the evening time limit. A complete list of the official Derby rules is shown in Figure 1.

PARTICIPATION:

Despite poor weather, participation in the derby was very good with all 48 registered boats fishing at least one day of the contest. Although it was required that a daily catch record (Fig. 2) be submitted by all participating boats at the end of each fishing day, many (25%) of these were found to be improperly filled out or not turned in at all. However, based on the records which were completed a fairly accurate estimate of the daily fisherman and boat participation is presented in Table 1. A total of 355 anglers making 120 separate boat trips were logged out during the three-day event. With approximately three anglers per boat spending an average 9.0 hours per boat trip, an estimated 3,200 man-hours of effort were expended this year.

THE CATCH:

Although the catch was not overwhelming, enough fish were landed to keep the derby exciting and some new records were set. Table 2 illustrates the daily catch by component species.

Fifty-six fish weighing 1,508 kg were officially censused as contest entries. This included 6 blue marlin with a total weight of 703.1 kg. The weight range for this species ran from 55.2 kg to 237.5 kg, with a mean of 117.2 kg.

Yellowfin tuna was the next largest contributor to the total weight of the derby catch, with 34 individuals providing 636.6 kg. The yellowfin weight range ran from 7.0 kg to 67.7 kg, with a mean of 18.7 kg.

Only five mahimahi were entered into the competition and these weighed a total of 52.6 kg. The weight range for this species was rather low running from 6.2 kg to 14.8 kg, with a mean weight of 10.5 kg.

A total of 115.8 kg of wahoo was censused for the derby. This was contributed by 11 individuals which weighed between 5.7 kg and 19.7 kg. The mean wahoo weight was approximately 10.5 kg.

Three new MFD records were set this year by the first-place marlin (237.5 kg), yellowfin tuna (67.6 kg) and mahimahi (14.3 kg). Although a 14.8 kg mahimahi was caught by a MFD participant, it was disqualified since the fisherman returned to the boat basin after the evening time limit. The record wahoo for this contest weighed 22.7 kg, and was caught during the first MFD in 1977. The weights of all of this year's prize-winning fishes, along with the approximate locations of their hook-up, is presented in Table 3 (see also Fig. 2).

SEX RATIO:

Sex determinations were made on 44 of the 56 fishes entered in this year's derby. This data is given in Table 4. Both the blue marlin and the yellowfin tuna displayed a male: female ratio of 1:1. Females accounted for most of the wahoo (1:2.7) and all of the mahimahi that were examined.

These ratios may be compared with those found for the first MFD catch (1977). During that contest the blue marlin ratio was 0.6:1; fairly close to this year's ratio. This is interesting since the blue marlin sex ratios from the 1962-1975 Hawaiian International Billfish Tournaments (HIBT) have consistently shown more males than females. It will be interesting to see if a near 1:1 ratio holds for this species in future derbies.

In 1977, the yellowfin tuna displayed a sex ratio of 1:1, while only female mahimahi and wahoo were caught. These ratios are very similar to those observed this year for the same species. The exception being the wahoo ratio. This year three of the eleven individuals examined were males.

FISHING AREAS:

As in past derbies, many of the participating boats were not equipped with short-wave radios. This makes it very difficult to pinpoint the areas of actual strikes and landings at the time of occurrence. However, based on the completed records for 44 of the 56 fishes that were entered general strike areas were determined. The areas and date of catch for these fish are summarized by species in Table 5. The fishing areas in this table may be identified on the map in Fig. 2.

Area 4 (Rota Banks) was the most productive in terms of numbers and weight of catch. Both the first-place marlin and mahimahi came from this region. Area 18/25 followed closely in both numbers and weight of catch. The winning wahoo was caught in Area 19 (Pati Pt.), while the first-place yellowfin was landed off of Hospital Pt., in Area 39, just a few miles away from the boat basin.

STOMACH CONTENTS:

Gut content analysis was performed on the same 44 fish. This data is shown in Table 6. Only 23% of the examined stomachs were found to be empty. The highest percentage of empty guts occurred among the wahoo (54.5%). In addition, nine of the 11 wahoo samples contained the trematode parasite *Hirundinella* sp., which more commonly appeared in the stomachs which were empty.

At the opposite end of the spectrum, none of the mahimahi were found to be empty, while the marlin and yellowfin samples showed low percentages of empty stomachs. The most common food item was fish, being found in 27 of the 44 samples.

NMFS OBSERVATIONS AND RECOMMENDATIONS:

The following are the most important observations and recommendations submitted to the GFBA by Mr. Heeny S. H. Yuen, Recreational Fisheries Leader at the NMFS Honolulu Laboratory:

"(1) When a boat came in with a fish, the biologist usually transferred the fish to land and weighed it. The boat waited at the dock while he measured and examined the fish. During the closing hours of each day the boats arrived at a rate faster than the biologist could handle the specimens. The result was a collection of boats at the dock.

"Recommendation: Have a special staff to transfer and weigh the fish. Limit the biologist's role to measuring and examining the fish and recording data. Have fishermen dock their boats and pick up their fish later. Set aside an area in which the fish can be lined up if the fish arrive too fast for the biologist to keep up.

"(2) Forms that were passed out to fishermen when they left for fishing were sometimes not returned or improperly filled or not filled at all.

"Recommendation: Conduct a briefing session to explain how the form should be filled and to emphasize the importance of the data which the form is designed to obtain.

"(3) Hours of fishing were from 5 a.m. to 9 p.m., on the first two days and 5 a.m. to 5 p.m., on the third day. The biologist was there to pass out forms at the beginning of the day and waited all day for boats returning with a catch because it was unpredictable when boats would return.

"Recommendation: Establish a requirement that each boat in the Derby have a radio and set up a shoreside communications system. Require boats to communicate their arrival time with as much lead time as possible. Such a system would free the biologist to leave the area for short periods of time. But much more important than the convenience of the biologist is the measure of safety the system would provide.

"(4) It appeared to me that the Derby committee and the biologist were interested in some of the same information.

"Recommendation: Both parties get together and coordinate their forms to facilitate exchange of data of mutual interest."

Basically, we aggree with all of Mr. Yuen's recommendations. The only exception might be the requirement that every Derby boat have a radio on board. Of course, that would be the desired situation, and one which we would support; but it may prove to be detrimental to the success of the Derby if such a rule were to exclude many of the fishermen who would otherwise participate. Since the Derby is relatively young, public interest in participating is still increasing. It may be best to allow this interest to level off before implementing a rule which will obviously have a negative impact on participation.

Report prepared by Michael E. Molina

Table 1. Daily Participation In the Third Annual Marianas Fishing Derby.

DATE	NO. BOATS	AVG. BOAT TRIP (HRS)	NO. MEN	AVG. MEN PER BOAT	NO. LINES	AVG. LINES PER BOAT
20 July	39	10.4 ± 3.3	114	2.92	185	4.74
21 July	44	9.5 ± 2.9	130	2.95	209	4.75
22 July	37	6.9 ± 2.6	111	3.00	167	4.51
TOTAL	120	9.0	355	2.96	561	4.68

Table 2. Daily Catch For The Third Annual Marianas Fishing Derby.

	BLUE MARLIN		YELLOWFIN		MAHIMAHI		WAHOO		TOTAL		OTHERS[1/]
DATE	NO.	KG	NO.	KG	NO.	KG	NO.	KG	NO.	KG	NO.
20 July	2	363.6	21	362.6	2	21.0	6	60.3	31	807.5	35
21 July	2	129.3	9	192[2/]	3	31.6	2	15.5	16	368.4	52
22 July	2	210.2	4	82[2/]	0	00.0	3	40.0	9	332.2	7
TOTAL	6	703.1	34	636.6	5	52.6	11	115.8	56	1,508.1	94[1/]

1/ Other species caught included skipjack tuna (Katsuwonus pelamis)-75, rainbow runner (Elagatis bipinnulatus)-9, barracuda (Sphyraena barracuda)-8, dogtooth tuna (Gymnosarda nuda)-1, and kawakawa (Euthynnus affinis)-1; this total may not be accurate since these species did not have to be recorded.

2/ 3 small yellowfin were registered but not weighed in; the total weights are adjusted to reflect these.

Table 3. Prize Winners For The Third Annual Marianas Fishing Derby.

CATEGORY		WEIGHT (KG)	APPROX. LOCATION	BOAT NO.	ANGLER
Marlin	1	237.5	Rota Banks	042	P. Cruz
	2	133.9	Ritidian Pt.	920	F. Leon Guerrero
	3	126.0	Orote Pt.	591	W. Manley
Yellowfin	1	67.6	Hospital Pt.	920	F. Leon Guerrero
	2	66.3	Ritidian Pt.	305	H. Sablan
	3	45.4	Hospital Pt.	994	J. Cruz
Mahimahi	1	14.3	Rota Banks	423	J. Quitugua
	2	8.8	Uruno Pt.	424	J. Nelson
	3	8.5	Ritidian Pt.	493	W. Schubert
Wahoo	1	19.7	Pati Point	201	L. Sorenson
	2	18.1	Rota Banks	475	L. Summers
	3	13.2	Ritidian Pt.	550	G. Camacho
		NO.			
TOTAL CATCH	1	8	-	920	F. Leon Guerrero
	2	6	-	247	A. George

Table 4. Sex Ratios and Mean Weights for 55 of the 56 Fish Entered for Prizes During the 1979 MFD.

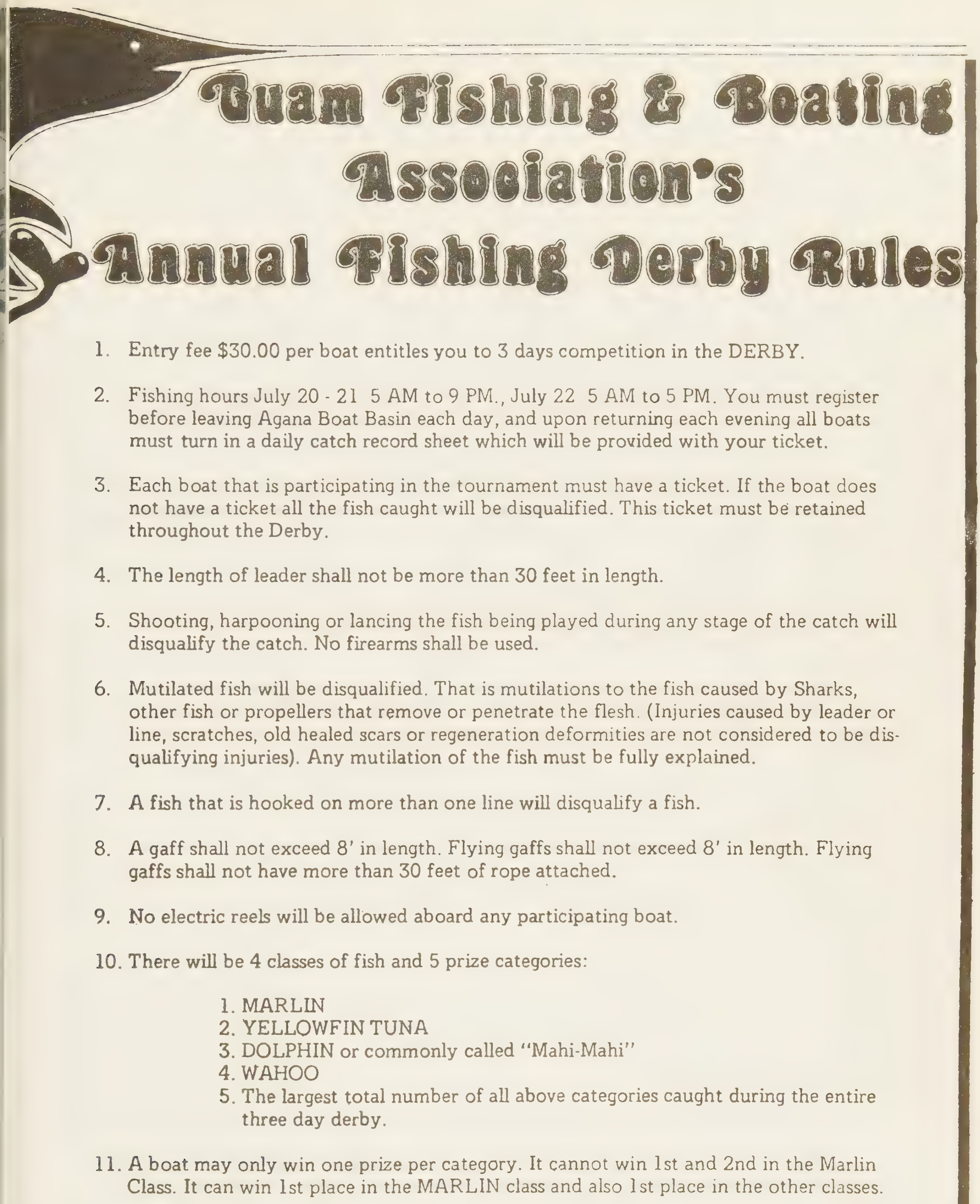
SPECIES	MALES		FEMALES		RATIO
	No.	$\bar{X}$ Wt.	No.	$\bar{X}$ Wt.	MALES:FEMALES
Blue Marlin	3	68.4	3	165.9	1:1
Yellowfin Tuna	11	29.0	11	26.3	1:1
Mahimahi	0	-	5	6.3	-
Wahoo	3	9.9	8	10.8	1:2.7

Table 5. Number of fish entered for prizes by species, date and area of catch during the 1979 MED. (see also Fig. 2).

SPECIES	FISHING AREAS							
	4	18/15	19	39	51	65	70	85
BLUE MARLIN:								
July 20	1	-	-	-	1	-	-	-
21	1	1	-	-	-	-	-	-
22	-	2	-	-	-	-	-	-
TOTAL	2	3	0	0	1	0	0	0
AUG. WT. (KG)	155.8	85.5	0.0	0.0	126.1	0.0	0.0	0.0
YELLOWFIN TUNA:								
July 20	3	2	7	4	-	-	1	4
21	3	1	2	1	-	-	1	1
22	3	-	1	-	-	-	-	-
TOTAL	9	3	10	5	0	0	2	5
AUG. WT. (KG)	17.8	29.9	9.9	42.0	0.0	0.0	17.8	8.5
MAHIMAHI:								
July 20	1	-	-	-	-	1	0	-
21	1	2	-	-	-	-	0	-
TOTAL	2	2	0	0	0	1	0	0
AUG. WT. (KG)	14.6	8.6	0.0	0.0	0.0	6.2	0.0	0.0
WAHOO:								
July 20	2	3	-	-	-	-	-	1
21	1	-	1	-	-	-	-	-
22	-	2	1	-	-	-	-	-
TOTAL	3	5	2	0	0	0	0	1
AUG. WT. (KG)	11.2	9.6	14.1	0.0	0.0	0.0	0.0	15.8
TOTAL NO.	16	13	12	5	1	1	2	6
% TOTAL NO.	28.6	23.2	21.4	8.9	1.8	1.8	3.6	10.7
TOTAL KG	534.6	410.7	127.2	209.6	126.1	6.2	35.6	58.1
% TOTAL KG	35.4	27.2	8.4	13.9	8.4	0.5	2.4	3.8

Table 6. Food Items and their Occurrence in 44 Gut Samples Taken at the 1979 MFD, By Species of Fish.

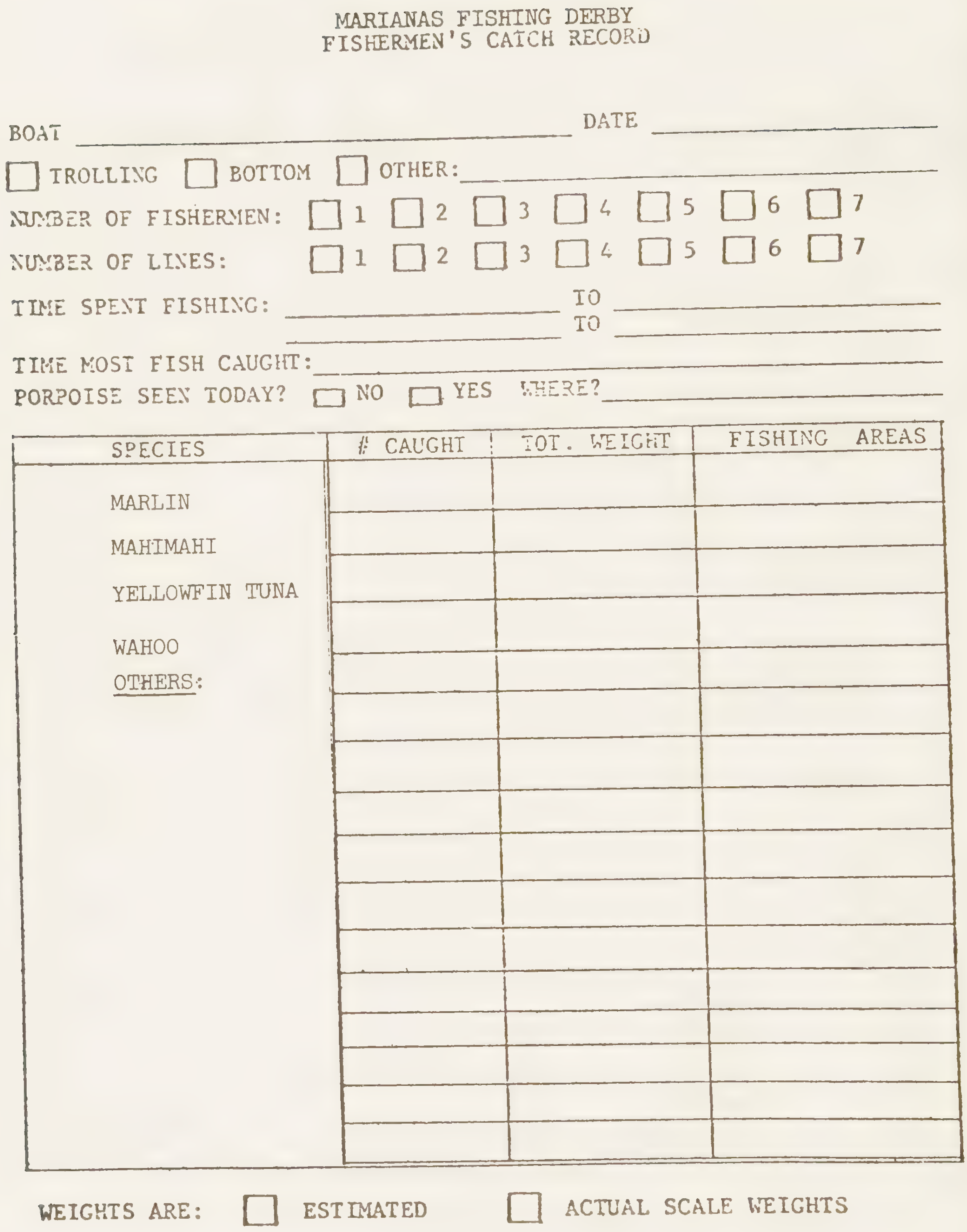
FOOD ITEMS	NO. OF STOMACHS CONTAINING LISTED FOOD ITEMS				
	Blue Marlin	Yellowfin Tuna	Mahimahi	Wahoo	All Species
FISH:	5	13	5	4	27
Acanthuridae	0	2	0	1	3
Balistidae	2	11	3	2	18
Belonidae	0	1	0	0	1
Carangidae	1	0	2	0	3
Chaetodontidae	0	1	0	0	1
Clupeidae	0	0	1	0	1
Diodontidae	0	3	1	1	5
Dussumieridae	1	1	0	0	2
Exocoetidae	0	1	2	1	4
Gemplyidae	1	1	0	0	2
Holocentridae	0	1	0	0	1
Menidae	0	3	2	0	5
Molidae	0	1	0	0	1
Monacanthidae	0	1	1	1	3
Mugilidae	0	0	1	0	1
Ostraciontidae	0	4	0	0	4
Scombridae	2	1	0	1	4
Synodontidae	0	1	0	0	1
Tetraodontidae	0	1	0	1	2
Unidentified Fish	2	3	3	0	8
INVERTEBRATES:	3	13	1	0	17
Crab Larvae	0	3	0	0	3
Mantis Shrimp	0	9	0	0	9
Squid	3	5	1	0	9
Unidentified Worm	0	0	1	0	1
NO. STOMACHS EXAMINED	6	22	5	11	44
NO. EMPTY STOMACHS	1	3	0	6	10
PERCENT EMPTY	16.7	13.6	0.0	54.5	22.7



Guam Fishing & Boating Association's Annual Fishing Derby Rules

1. Entry fee $30.00 per boat entitles you to 3 days competition in the DERBY.
2. Fishing hours July 20 - 21 5 AM to 9 PM., July 22 5 AM to 5 PM. You must register before leaving Agana Boat Basin each day, and upon returning each evening all boats must turn in a daily catch record sheet which will be provided with your ticket.
3. Each boat that is participating in the tournament must have a ticket. If the boat does not have a ticket all the fish caught will be disqualified. This ticket must be retained throughout the Derby.
4. The length of leader shall not be more than 30 feet in length.
5. Shooting, harpooning or lancing the fish being played during any stage of the catch will disqualify the catch. No firearms shall be used.
6. Mutilated fish will be disqualified. That is mutilations to the fish caused by Sharks, other fish or propellers that remove or penetrate the flesh. (Injuries caused by leader or line, scratches, old healed scars or regeneration deformities are not considered to be disqualifying injuries). Any mutilation of the fish must be fully explained.
7. A fish that is hooked on more than one line will disqualify a fish.
8. A gaff shall not exceed 8′ in length. Flying gaffs shall not exceed 8′ in length. Flying gaffs shall not have more than 30 feet of rope attached.
9. No electric reels will be allowed aboard any participating boat.
10. There will be 4 classes of fish and 5 prize categories:
    1. MARLIN
    2. YELLOWFIN TUNA
    3. DOLPHIN or commonly called "Mahi-Mahi"
    4. WAHOO
    5. The largest total number of all above categories caught during the entire three day derby.
11. A boat may only win one prize per category. It cannot win 1st and 2nd in the Marlin Class. It can win 1st place in the MARLIN class and also 1st place in the other classes.
12. All fish must be certified by an authorized DERBY WEIGHMASTER OFFICIAL.
13. All decisions of the judges shall be final.
14. Award ceremony at 6PM on July 22 at the Agana Boat Basin.

igure 1. Official Marianas Fishing Derby rules.



MARIANAS FISHING DERBY
FISHERMEN'S CATCH RECORD

BOAT ______________________ DATE ______________

☐ TROLLING ☐ BOTTOM ☐ OTHER: ______________

NUMBER OF FISHERMEN: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

NUMBER OF LINES: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

TIME SPENT FISHING: ______________ TO ______________
______________ TO ______________

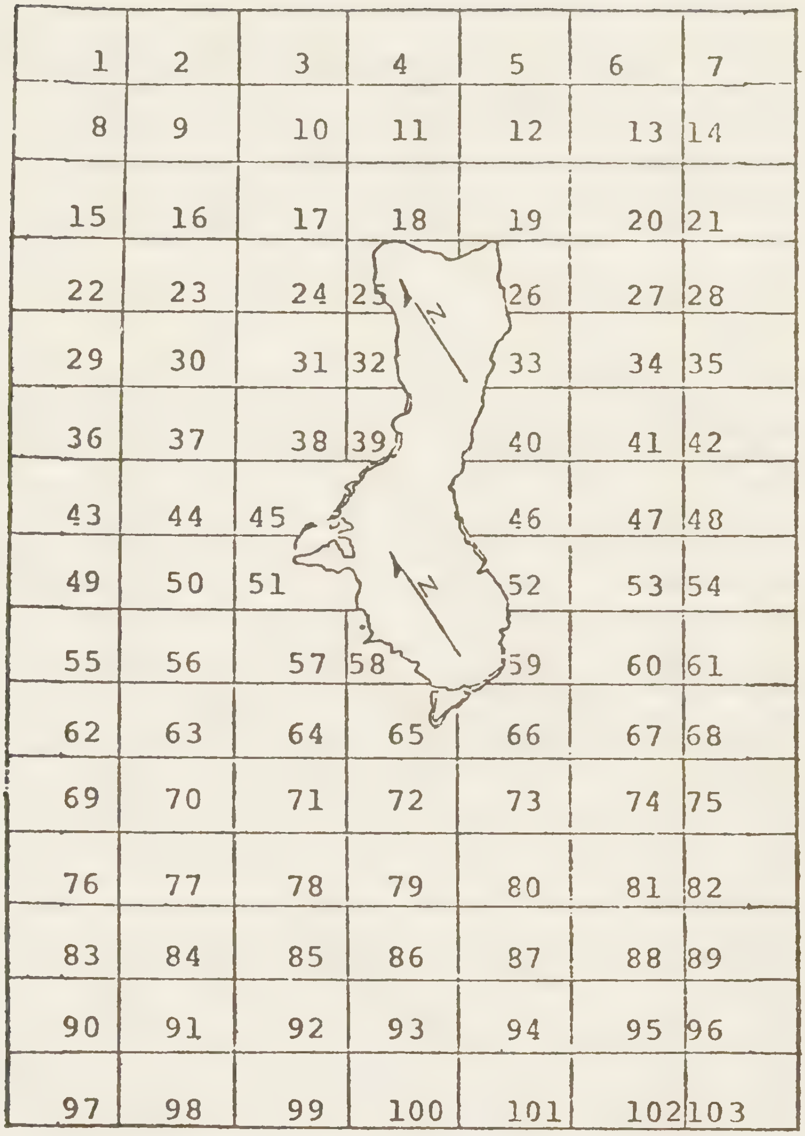
TIME MOST FISH CAUGHT: ______________

PORPOISE SEEN TODAY? ☐ NO ☐ YES WHERE? ______________

SPECIES	# CAUGHT	TOT. WEIGHT	FISHING AREAS
MARLIN			
MAHIMAHI			
YELLOWFIN TUNA			
WAHOO			
OTHERS:			

WEIGHTS ARE: ☐ ESTIMATED ☐ ACTUAL SCALE WEIGHTS

Figure 2. Fishermen's Daily Catch Record used during the 1979 MFD.


1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31 32 33 34 35
36 37 38 39 40 41 42
43 44 45 46 47 48
49 50 51 52 53 54
55 56 57 58 59 60 61
62 63 64 65 66 67 68
69 70 71 72 73 74 75
76 77 78 79 80 81 82
83 84 85 86 87 88 89
90 91 92 93 94 95 96
97 98 99 100 101 102 103
N
N

FISHING AREA NUMBERS;
FILL IN ON OTHER SIDE
GRID SCALE:
APPROX. 5 mi. x 8mi.
4 = Rota Bank
12 = 45^{o} Bank
18/25 = Ritidian Pt.

19 = Pati Pt.
25 = Uruno Pt.
39 = Hospital Pt.
51 = Orote Pt.
70 = 11mi. (17mi.) Reef
85 = Galvez Bank
100 = Santa Rosa Reef

Figure 2. Continued.

PROJECT TITLE: Feasibility Study to Establish an Ika-Shibi Fishery on Guam

PERIOD COVERED: October 1978 to May 1979

FUNDING SOURCE: Pacific Tuna Development Foundation

INTRODUCTION:

In recent years in Hawaii, a night handline fishery for tunas concentrated in the vicinity of Hilo has grown tremendously. Originally kept secret by the Japanese, the method is believed to have been started in Hawaii by Okinawans fishing for squid at night. They realized that many of the big strikes they were getting on their squid lines were large tunas, and geared up to catch them. The method probably was started in the early 1900's, and became known as "ika-shibi." It evidently did not become common knowledge until about 1970, and it has grown significantly in importance in recent years with larger numbers of boats participating. The method is desirable to fishermen because they catch the larger bigeye and yellowfin tuna, the gear is simple, inexpensive and effective, and there is very little fuel consumption since the engines are shut off during the fishing process.

In early 1978, the Aquatic and Wildlife Resources Division (AWR) of the Guam Department of Agriculture submitted a proposal to the Pacific Tuna Development Foundation (PTDF) for a "Feasibility Study to Establish an Ika-Shibi Fishery on Guam." In May, it was recommended by Mr. David Nada of PTDF that Mr. Ronald Strong of AWR, who was in Hawaii at the time, visit Hilo for the purpose of interviewing and selecting an experienced ika-shibi fisherman for the Guam project. On the recommendation and assistance of Mr. Marvin Iida of the County of Hawaii's Department of Research and Development, Mr. Strong interviewed and offered a contract to Mr. Toyoki Morimoto of Hilo to conduct the study on Guam. The amount of the contract was recommended by Mr. Nada and an agreement was signed between the Government of Guam and PTDF in June 1978 for a one year study. This was later modified to a six month study.

Due to administrative delays, the contract to hire Mr. Morimoto was not signed until September, and he arrived on Guam on October 12, 1978. The problem of finding a suitable boat to lease for the six month project was not resolved until December 1, when the AWR division leased the 28', twin-diesel "Lois Ann", owned by Mrs. Lois Scruggs of Merizo, Guam. Thus the actual fishing program did not get underway until December 4, 1978.

Prior to actually starting to fish, Mr. Morimoto spent his time locating sources of necessary equipment on island, fabricating gear, familiarizing himself with the local waters, and giving presentations on gear fabrication and technique to local fishermen and fishing groups such as the Guam Fishermen's Cooperative Association and the Guam Fishing and Boating Association. He also went out on privately owned small boats to demonstrate the fishing technique.

Mr. Morimoto's contract expired and he left the island on April 11, 1979. Since there was a time lag in leasing a fishing vessel, the AWR Division had the use of the "Lois Ann" through May. We were able to continue the ika-shibi program under the able supervision of Mr. Tom Hale, who had captained the "Lois Ann" and had become very familiar with the fishing methodology. He continued ika-shibi fishing through the end of April. During May, day handlining and scouting for schools of tuna constituted the majority of the trips.

Methodology

Lines

The ika-shibi method involves fishing at night with a weighted handline, baited with either squid or mackerel, in fairly deep water. The boat is held in place with the aid of either a surplus cargo parachute or a regular sport jumping chute as a sea anchor, and there is very little fuel consumption during the fishing operation. Usually 2 or 3 lines are used, one on either side of the stern and one from the bow (Figure 1). On smaller boats, one or two lines may be utilized.

Each handline consists of four parts: the handline itself, a curved, tubular sinker, the leader and the hook (Figure 2). The handline itself usually consists of approximately 75-125 fathoms of 5/16" or 3/8" polypropylene line, however, tarred trawl line or "Super Toto" type line (approximately 375 lbs. breaking strength) can be used. The line used should resist tangling and be easily handled and coiled.

The sinker is specially constructed of a 12" length of ½ diameter copper tubing filled with lead. The tubing is curved (30^o arc) to prevent rolling around on the deck of the boat, and is fitted with stainless steel eyes and swivels on both ends. The polypropylene line is attached to one of the swivels, and to the other end of the sinker is attached approximately 4 fathoms of leader wire (usually cloth covered, such as Sekiyama) or a length of tarred trawl line. To this, a ½ to 1 fathom long stainless steel leader (500 lbs. test) is attached by means of an armor spring or pig tail swivel. The hook is usually a tuna long line hook or a large Japanese style circle hook (Mustad No. 3 or No. 4). The entire handline is coiled into either a plastic basket or wooden box to facilitate handling and storage (Figures 3 and 4).

When the lines are set in the water, they are temporarily fastened to the boat with a light break-away line (usually monofilament, 80-100 lbs. test). This is used to set the hook firmly in the fish when it strikes.

Bait

If squid are attracted close to the boat by the lights, it is possible either to gaff them or to catch them on a Japanese style squid fishing jig. It appears that live squid is the preferred bait for ika-shibi fishing, and if these could be caught fresh during each fishing trip, it would reduce the cost of bait considerably.

If live squid are not available, opelu or mackerel scad (Decapterus pinnulatus) which can be caught locally in Apra Harbor seem to be the best bait. A third choice would be either atulai (bigeyed scad, Trachurops crumenopthalmus) available locally or imported mackerel which can be purchased either fresh or frozen in local stores.

The bait should be rigged by placing the hook through the mouth and gill opening or, preferably, by threading both the hook and leader through both eyes and imbedding the hook below the dorsal fin under the backbone so that the tip of the exposed hook faces forward and slightly upward. The latter method helps prevent bait loss and unsuccessful strikes when the fish takes only the lower part of the bait, or smaller fish nibble at the bait.

The bait must be checked every 20 to 30 minutes to ensure that it is intact. Squid frequently nibble on the bait, especially if squid is used, necessitating frequent checks. Mackerel bait is bothered less by the free swimming squid.

Lights

Depending on the length (depth) of the lines being used and whether or not the fisherman wishes to attract squid near the boat, various types and combinations of lights may be utilized. In Hawaii it is common to hang one or two 25 watt lights just above the water's surface and one 50 watt light just below the surface. These are 12 VDC bulbs, and are powered by a heavy duty 12 V battery. The bulbs are readily available on Guam and the only modification that needs to be done to the underwater unit is to seal the base of the bulb in the rubber socket with silicone rubber, which is easily removed when the bulb needs changing. A reflector for the underwater light is optional, but is generally used if above-water lights are hung over the side.

Since the depth that the fishing lines were lowered to was much deeper in Guam than the normal 7-30 fathoms in Hawaii (due to the warmer surface water here), it was felt that the underwater light served no purpose in attracting the tunas or illuminating the bait. Therefore, if no squid fishing was planned, an underwater light was not used. Instead a light attached to the leader approximately one fathom from the bait (below the sinker) would probably be more effective. A chemical light (Cyalume) and a small plastic battery powered light (Dialite) were tried. The Cyalume light functioned down to 40 fathoms, but imploded at deeper depths. The Dialite also leaked at depth, so another device needs to be found which will operate at depths between 50 and 60 fathoms. One possibility is a small luminescent device which attaches to the loop in the leader just above the hook (a Japanese Fuji-Aimata) and lasts for approximately 4-6 hours. This device was not tested, but is now available locally.

PROCEDURES:

An Ika-Shibi trip begins by departing for the fishing area early enough so that the site can be reached during daylight. This enables the fisherman to locate a school of tunas and then remain with the school by setting the sea anchor at sunset. This procedure undoubtedly increases the chances for success, for if the fisherman arrives at the site after dark he will be guessing where the best spot might be, and is not assured that fish are in the area.

Although the best fishing areas in Hawaii often times are located close to the 1000 fathom contour, it is probably a combination of water depth, current and water temperature which determines where the baitfish and tuna are. Since the 1000 fathom depth contour around Guam is in some areas far offshore in very rough water, and is normally not on a steep dropoff with a current line present, this depth contour did not dictate the areas that were surveyed. Mr. Morimoto generally looked for and fished in areas characterized by a strong current line, and he did not feel that depth was the most important factor.

When a location has been selected, the sea anchor (parachute) is set off the bow of the boat and the bridle lines are firmly attached and protected with chaffing gear (Figure 5). A trip line, attached to the apex of the chute, is necessary to allow the fishermen to deflate it and haul it aboard (Figure 6). It also serves as a safety line should the main line break. Generally, a small buoy is attached to the trip line to facilitate setting and keeping track of the chute and prevent it from sinking. Since the boat may have to be moved during the night to remain with the fish, the sea anchor should be rigged so that it is easily deployed and retrieved, and the lines should be large enough so that they do not break and can be handled easily.

The handlines initially were lowered to depths comparable to those in Hawaii, about 10 to 30 fathoms. However, the catch and strike rates were very low and it was felt that due to the warmer surface water around Guam the lines should be fished deeper. Also, the ika-shibi program in Truk was most successful at a 40 fathom fishing depth, although there they often fished a second line at 25 fathoms. Although the lack of a suitable underwater light restricted the fishing to 40 fathoms, Mr. Morimoto believes that the optimum depth is probably somewhere between 40 and 60 fathoms.

When the handline has been lowered to the chosen depth, a break-away line is attached to hold it in place and the fishing begins. Care must be taken to see that the bait remains intact, and this generally requires hauling and resetting every 30 minutes. The position of the boat and sea anchor must be monitored and the fathometer checked periodically to ensure that the boat is over the fish. Free time may be spent resting, or jigging or netting squid to use as bait. Fishing generally ends at sunrise, but day handlining or trolling can then be conducted.

RESULTS:

Fishing activity began on 4 December 1978, and a total of 39 trips were conducted during the five month period ending 30 April 1979. From December to February, most of the areas fished were off the southern part of the island. During February and March, the survey was concentrated in the central and northern areas. A summary of the fishing dates, areas, catch and water depths is given in Table 1, and Figure 7 shows the fishing locations for each trip.

The total catch during the five month period was not impressive. It consisted of one yellowfin tuna (*Thunnus albacares*, 14 lbs.), one barracuda (*Sphyraena barracuda*, 10 lbs.) three Mahi-Mahi (*Coryphaena hippurus*, 30 lbs.,), two broadbill swordfish (*Xiphias gladius*, 170 lbs.), three oil fish

(Ruvettus pretiosus), and 10 assorted sharks which were released. Very little was caught in the south, and the northern areas seem to be the most promising. The two broadbill swordfish were caught off Orote Point and Ritidian Pt. This species is very rarely landed on Guam, and the ika-shibi method may enable Guam's fishermen to exploit this yet untapped fishery.

Although the major species caught in Hawaii by the Ika-shibi method are the yellowfin tuna (Thunnus albacares) and the bigeye tuna (Thunnus obesus), only one 14 pound yellowfin was caught during this survey. Yellowfin probably were not caught during this survey because they do not come into season around Guam until early summer, and leave again in September or October. It is possible that a resident population may be present around the offshore seamounts and banks which could be caught using the ika-shibi method.

A total of 10 sharks were caught during the 39 trips, and others probably were the cause of hook and line loses and unsuccessful strikes. Sharks may continue to be a problem during night fishing, or they may be less of a problem when one is fishing in a large school of tuna. It is possible that a shark fishery could be developed on Guam; however at present they are minimally utilized and generally are not even landed by most fishermen.

A total of 46 people participated in at least one ika-shibi trip during the program. Those fishermen are now familiar with with the gear set-up and fishing techniques, and it will be up to them to pursue and develop this method if a season exists on Guam, and determine if an ika-shibi fishery can be profitable. Since the gear is simple and inexpensive, and fuel consumption is low, the potential for developing a viable tuna fishery for Guam is promising.

RECOMMENDATIONS:

Based on the 5 months of fishing surveys, and interviews with Mr. Morimoto and other knowledgeable fishermen, it appears that the waters surrounding Guam could most likely support a small-scale ika-shibi fishery. However, it will take the perseverance and hard work of a few, or perhaps even a single fisherman, to locate the schools of fish and determine the seasonality of the fishery before it can be a viable component of Guam's growing fishing industry.

The Aquatic and Wildlife Resources Division and fishing consultant Toyoki Morimoto have come to the following conclusions and recommendations:

(1) The PTDF-funded study was successful despite the low catch rates. More than 45 people participated in fishing trips and observed and learned the techniques required for ika-shibi fishing.

(2) Although the program did not run for 12 months and therefore could not determine the seasonality of the fishery, the best time of the year for ika-shibi fishing is probably in the late summer, July through September or October.

(3) The handlines should be fished at depths between 40 and 60 fathoms for best results. Since the surface underwater light will not illuminate the bait at these depths, a small light should be attached to the line approximately ½ - 1 fathom from the bait, but this light must be able to withstand the pressure at these depths. Another option is to use the small luminescent device, called a Fuji-Aimata, which attaches to the loop in the leader above the hook.

(4) When ika-shibi fishing, the fisherman should leave early enough to reach the fishing grounds before sunset so he can locate the fish, set his gear, and check coordinates before dark.

(5) A good quality fathometer which reads to 300 fathoms (100 fathoms minimum) is recommended. This can be used not only for locating the banks and seamounts, but to locate and keep track of fish that are below the surface.

(6) The most promising location for ika-shibi is an area between Uruno Pt. and Ritidian Pt., approximately ½ to 1 mile from shore, where a strong current line is present. This area may extend as far south as Tanguisson Pt.

(7) Other potentially good areas include the large seamount located 25 miles due West of Uruno Pt. and the area around the Rota Banks.

FUNDING:

The funding for this study came from a Pacific Tuna Development Foundation grant to the Aquatic and Wildlife Resources Division of the Department of Agriculture. The amount of the grant and the expenses incurred by the project are itemized below:

Grant Amount:			$39,102.00
Expenses:			
Salary - Mr. Toyoki Morimoto, Fisherman, 6 months	-	$24,000.00	
Travel and Per Diem:			
Honolulu to Guam, Mr. Morimoto	-	$278.40	
Guam to Honolulu, Mr. Morimoto	-	$313.40	
Advertisement for Lease of Fishing Vessel	-	$73.92	
Lease of Fishing Vessel, 6 months	-	$12,000.00	$36,665.72
Balance (returned to PTDF)	-		$ 2,436.28

Report prepared by: Ronald D. Strong
Edited by: Staff

TABLE I. Summary of the areas fished and catch data for the ika-shibi survey.

December through April, 1979

M = Mackerel; S = Squid (Fresh); FS = Frozen Squid; ST = Skipjack Tuna

Trip No.	Date	Area	Water Depth (fathoms)	Line Depth (fathoms)	Bait	Hours Fished	Catch Species/Weight (lbs)	Time	Squid Seen or Caught
1.	Dec. 4	7 mi SW of Cocos	750	12-20	S/M	3.5	none	-	caught 5
2.	Dec. 6	4 mi W of Facpi Pt.	960	12-20	M	13	1-6' shark (cut loose)	0230	saw a lot
3.	Dec. 12	3 mi SW of Cocos	800	12-30	M/S	11	none	-	caught a few
4.	Dec. 14	3 mi W of Agat	500	30	M	9	1- Yellow Fin Tuna, 14 lbs.	0300	saw a few
5.	Dec. 16	Galvez Banks	250	20	M	13.5	none - lost 3 hooks w/ line	-	saw a lot
6.	Dec. 18	1 mi W of Umatac	200	20	M	13	none	-	saw small ones
7.	Dec. 20	Galvez Banks	300	20	M	13	1 - Barracuda, 10 lbs.	1130	saw a lot
8.	Jan. 2	10 mi W of Sella Bay	750	20-30	M	10	none	-	no
9.	Jan. 4	8 mi W of Facpi Pt.	920	20-30	M	9.5	none	-	no
10.	Jan. 6	6 mi W of Facpi Pt.	1000	20-30	M	10	none	-	no
11.	Jan. 14	10 mi W of Cocos	600	20-30	FS	10.5	none	-	saw some
12.	Jan. 16	14 mi W of Umatac	700	20-30	FS/M	11	none	-	saw some
13.	Jan. 18	11 mi W of Umatac	700	20-30	FS/M	10.5	none - four strikes	-	saw some
14.	Feb. 6	5 mi W of Agat Bay	980	20-30	M	10	none	-	no
15.	Feb. 8	3 mi W of Orote	600	30	M	8.5	1-Broadbill Swordfish, 20 lbs.	0030	no

Table I. (Continued)

							2 - Oil fish(thrown back)	?	no
16.	Feb. 10	1 mi W of Orote	400	12-30	M	8	2-Oil fish (thrown back)	?	no
17.	Feb. 12	1 mi W of Orote	200	12-30	M	8	none	-	no
18.	Feb. 17	1 mi W of Sella Bay	200	12	FS/M	8	1- Mahi Mahi 10 lbs.	1200	saw a lot
							1- Mahi Mahi 9½ lbs.	0020	
19.	Feb. 19	2 mi W of Cetti Bay	500	12-30	FS/M	8	none	-	no
20.	Feb. 21	2 mi SW of Cocos	800	12-30	ST	8.5	none	-	no
21.	Feb. 23	3 mi SSW of Cocos	820	12-30	M	8	1-4' shark(cut loose)	?	no
22.	Mar. 4	3 mi NW of Ritidian	280	40-50	M	11	1- Broadbill Swordfish, 150 lbs.	0230	no
							1-3' shark (cut loose)	?	
23.	Mar. 8	15 mi WNW of Ritidian	1100	40-50	M	10	1-150 lb. shark (cut loose)	?	no
24.	Mar. 10	25 mi WNW of Ritidian	1650	20	FS	8.5	1- Mahi Mahi 10 lbs.	1200	no
				40	M		1-4' Gray Shark (cut loose)	0230	
25.	Mar. 12	6 mi NW of Ritidian	350	20-40	M/ST	6	none	-	no
26.	Mar. 16	2 mi NW of Uruno	250	20-40	M/ST	9	none	-	no
27.	Mar. 17	3 mi W of Uruno	350	20-40	FS/M	9	none	-	no
28.	Mar. 21	7 mi W of Ritidian	400	20-40	M/S	8	none - 1 large strike	-	no
29.	Mar. 24	8 mi NW of Ritidian	600	20-40	M/ST	12	none	-	no
30.	Mar. 26	10 mi NW of Ritidian	650	20-40	M/ST	9	none	-	no
31.	Apr. 2	3 mi W of Haputo Pt.	320	20-40	M	9	none	-	no

Table I. (Continued)

32.	Apr. 4	4 mi W of Ritidian	250	20-40	M	9	1-150 lb. shark (cut loose)	?	no
33.	Apr. 7	3 mi W of Ritidian	260	40-50	M	9	1-60 lb. shark (cut loose)	?	no
34.	Apr. 10	1 mi W of Tarague	200	40-50	M	9	none	-	no
35.	Apr. 18	4 mi W of Double Reef	400	40-50	M	8.5	none	-	no
36.	Apr. 21	2 mi N of Ritidian	140	50	M	8.5	1-120 lb. Blue Shark (cut loose)	0015	no
							1-90 lb. Blue Shark (cut loose	0130	
							(Bait hit all night)		
37.	Apr. 23	5 mi NNW of Ritidian	280	55	M	8	1-120 lb. Hammerhead shark (cut loose)	1130	no
38.	Apr. 28	3 mi N of Ritidian	200	40-50	FS	9	none	-	no
39.	Apr. 30	1 mi W of Orote	400	30-40	M	7	none	-	no

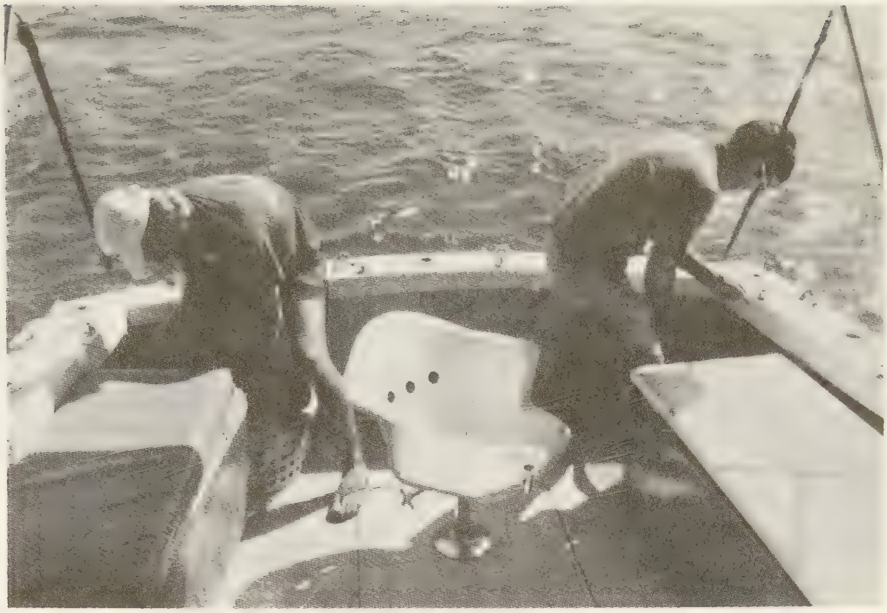


Figure 1. Fishermen deploying handlines used in ika-shibi fishing. On small boats such as this only one or two lines are used.

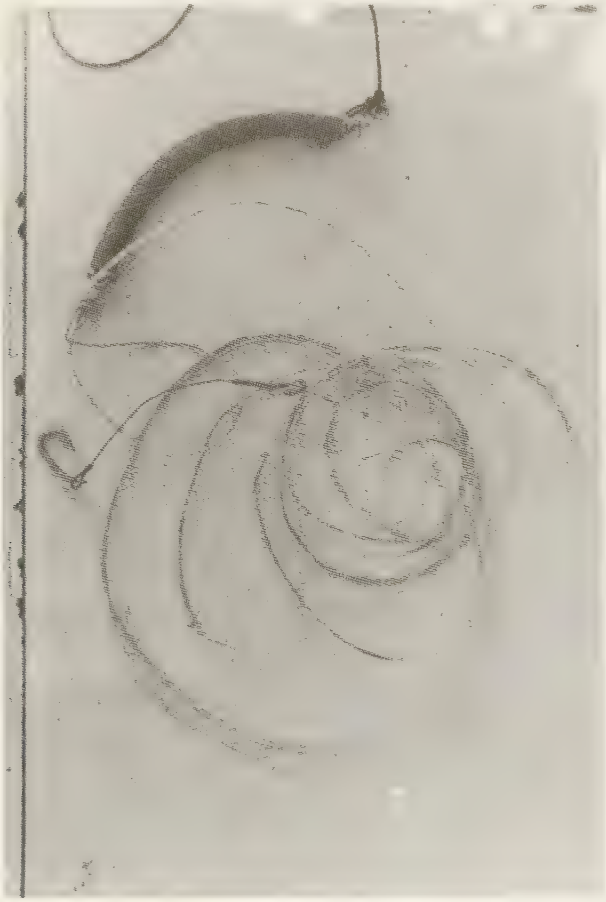


Figure 2. Design of handlines consists of four parts: the handline itself, a curved, tubular sinker, the leader and the hook.

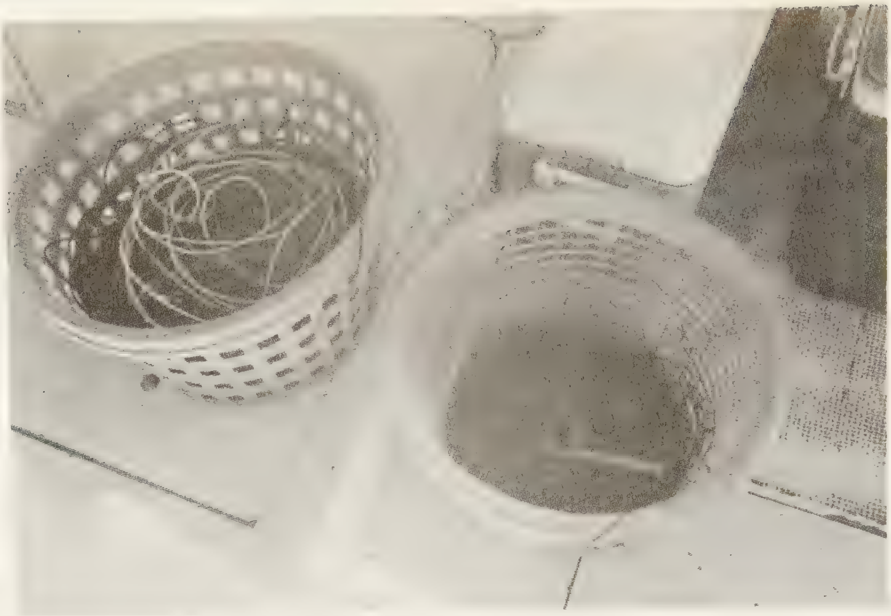


Figure 3. Handlines coiled in plastic laundry baskets are easily stored in stacks.

Figure 4. Lines carefully coiled in plastic baskets will allow a minimum of tangling as they are deployed.

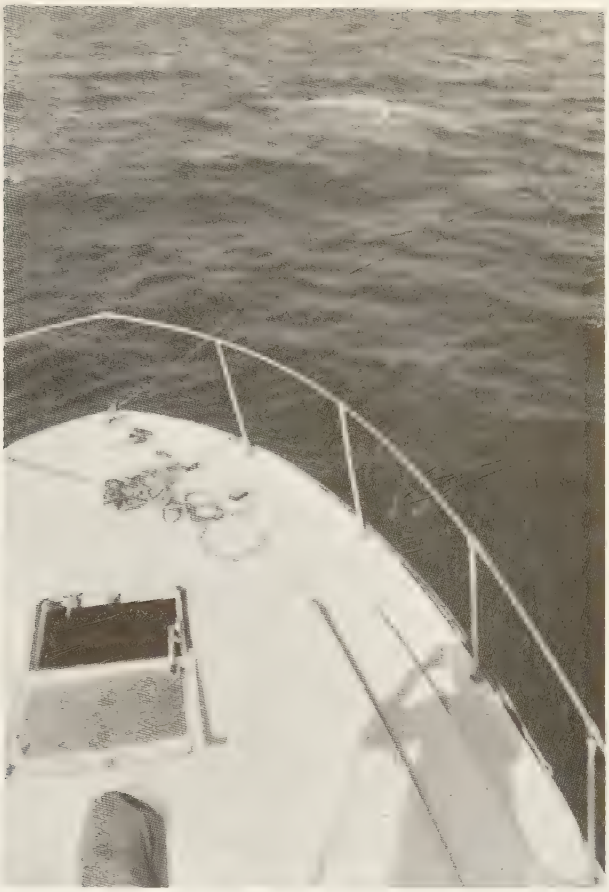


Figure 5. Proper positioning of sea anchor (parachute) is off the bow of the boat using bridled lines and proper chafting gear.

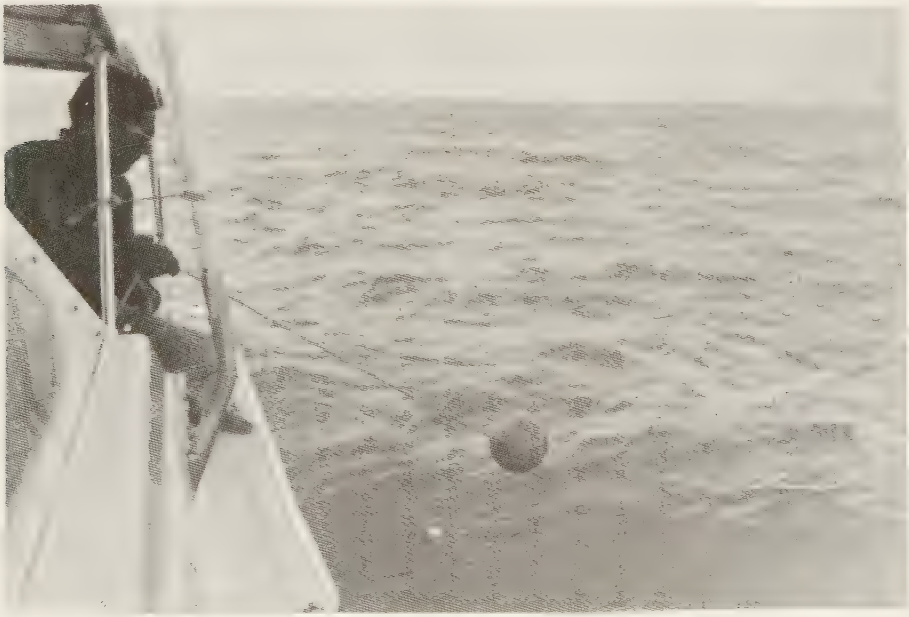


Figure 6. The sea anchor's resistance in the water requires the use of a trip line attached to the chut's apex to deflate it before it can be pulled in.

PROJECT TITLE: Survey of Edible Marine Shellfish and Sea Urchins on the Reefs of Guam.

PERIOD COVERED: June to September, 1978

FUNDING SOURCE: U.S. Department of Commerce, Office of Coastal Zone Management

The complete report of this study was published as Technical Report No. 2 of the Aquatic and Wildlife Resources Division, Guam Department of Agriculture, in September 1978. The study was conducted by Jeanine O. Stojkovich and Barry D. Smith under the supervision of the AWR staff. A limited number of copies are available at the Aquatic and Wildlife Resources Division Office in Mangilao, Guam.

ABSTRACT

The edible shellfish and sea urchin populations on the reefs of Guam were surveyed during the period 1 June through 23 August 1978. The sea urchins, Diadema savignyi and Echinothrix diadema, were surveyed and inspected periodically for gonad development. The highest population densities for D. savignyi were found at Piti and Agat. Large populations of E. diadema were found at Tumon, Piti, and Agat. Ripe gonads were not detected in either species during the study period. Both sea urchins were found to inhabit the reef margin and front where suitable overhangs and holes provide refuge. Piti reef flat was an exception. No size class zonations were observed for sea urchins.

Different size classes of Trochus niloticus were found to be distributed by reef zones. Juveniles (50 mm in shell diameter) inhabited the outer reef flat, and progressively larger size classes were found over the reef margin and down the reef slope to a depth of about 12 m. In isolated areas, the animals existed in depths down to 18 m.

Comparisons of population densities indicated similar numbers on the fringing reef of Tumon Bay and on the barrier reef of Cocos Lagoon. Areas inside lagoons contained few Trochus. In general, the population of Trochus on Guam is dense enough to support a limited commercial fishery.

There is a significant relationship between live wet weight and shell diameter of the animals. This relationship suggests that biomass estimations can be based on the equation: $W = 0.0003\ D^{3.03}$ where W is live wet weight (g), and D is shell base diameter (mm).

Populations of other edible bivalves are dense enough to support only a recreational fishery. Most species are presently harvested for home consumption. The greatest density of these bivalves occurs in seagrass beds in Cocos Lagoon.

Section III

Guam Fisheries Development
Project F-D-1
(Federal Aid in Fish Restoration Act)

PROGRESS REPORT
DEVELOPMENT PROJECT

STATE: Territory of Guam

PROJECT NO.: F-D

SUB-PROJECT NO.: F-D-1

PROJECT TITLE: Guam Fisheries Development

SUB-PROJECT TITLE: Masso Reservoir Development

Period Covered: July 1, 1978 to September 30, 1979

INTRODUCTION:

Fishing has been and still is an important activity for many people on Guam. Today fishing is not vital as a source of food, but it is highly valued as a leisure time recreational activity. Although saltwater fishing is available, there is no standing body of freshwater accessible to the general public for sport fishing. If a freshwater pond were available, it would be unique, and more importantly would provide fishing opportunities for the very young, senior citizens, and handicapped people who would enjoy fishing but are afraid or unable to fish in the ocean where high waves and strong currents are often present.

The Masso Reservoir was constructed by the U.S. Navy (possibly just prior to WW II, but probably in 1944 or 1945) for use as a potable water reservoir. It was abandoned on July 25, 1951 because siltation had made it unsuitable for water storage. It continued to silt in until only a small ¼-½ acre area of open water remained, and the rest was a marsh of elephant grass (Phragmites karka). The reservoir and the area around it became overgrown and forgotten except for an occasional eel or shrimp fisherman setting traps in the reservoir or feeder streams.

Aquatic organisms found in Masso Reservoir and its feeder streams include two eels (Anguilla mormorata and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis), an eleotrid (Eleotris fusca), several shrimps (Atya sp., Caridina sp., and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates. The vegetation is dominated by the reed Phragmites karka in wet areas, and by Leucaena leucocephala (tangan-tangan) on dry ground. Other trees in the area include Hibiscus tiliaceus, Pandanus sp., Spathodea campanulata (African tulip), Casuarina equisetifolia and Pithecellobium dulce.

The Masso Reservoir and immediately adjacent land (26 acres) is owned by the U.S, Navy, but has been turned over to the Government of Guam to manage its fish and wildlife resources. Its location near the population center of the island makes Masso Reservoir ideal for development into a freshwater fishing pond. In addition to providing recreational fishing, it will also be the focus of a park area providing picnic facilities, hiking, and camping in the reforested watershed area.

The objectives of the Masso Project have included the following:

1. Create a pond with several acres of open water suitable for stocking with forage and game fish;
2. Repair the retaining wall, spillway and sluice gate;
3. Create a variety of fish habitats within the pond with brush shelters, rock piles, etc,;
4. Fence in the spillway area to remove an "attractive nuisance" which is potentially dangerous to children and others;
5. Landscape the area around the pond, and plant attractive fruit shade, and ornamental trees and shrubs;
6. Stock the pond with fish;
7. Monitor the fish populations in the pond, and the fishermen's use of the pond.

PRESENT STATUS:

In 1978, the Black Construction Company working under contract to the Aquatic and Wildlife Resources Division cleared about two acres of the pond by removing the Phragmites grass, and repaired the spillway. There remain about another 2 acres of Phragmites at the mouths of the two tributaries which empty into the reservoir. When full, the pond has a surface area of about 2½ acres (open water) and a maximum depth of about 8 feet.

Between July and December 1978, YCC and CETA personnel planted hundreds of trees and shrubs on the hillsides of the Masso watershed. A list of the species planted is presented in Appendix A. The plantings have been weeded and fertilized several times to help ensure their success.

A draft environmental impact statement for the introduction of exotic fish into Masso Reservoir was submitted to the U.S. Fish and Wildlife Service (FWS) in March, 1978. The DEIS was reviewed by the FWS and found to be inadequate in its treatment of the potential problems. It was suggested that the required process to complete an acceptable EIS and have it reviewed would be far more time consuming and costly than the project warrants. In view of this attitude adopted by the FWS, it was decided not to use Federal funds to stock the Reservoir with exotic species of forage and game fish. It is uncertain at this time exactly what will be done with the Reservoir since there are no species suitable for stocking which are indigenous to or have become established in Guam's rivers. (The DEIS and related correspondence are presented in Appendix B.)

RECOMMENDATIONS:

We recommend that other means of stocking the reservoir with exotic fish species be explored. The island's pet store owners have agreed to supply fish for stocking as a public service, and this should be considered if approval is received from the Animal Import Screening Committee and any and all objections to the proposed stocking have been carefully considered.

In the event that fish are stocked, objectives 3, 4 and 7 above should be met. Objective 7, monitoring the fish and fishermen, could be implemented as a Job under the Guam Fish and Wildlife Investigations project. Fish habitats and further landscaping could be handled through future YCC projects at very little expense. Fencing the spillway is a job that would have to be contracted out, and may be necessary whether the reservoir is stocked or not.

Report prepared by: Henry G. Tucker and R. Logan Kock

APPENDIX A

MASSO PLANTING REPORT

The following is a brief description of those areas around the Masso Reservoir that were planted with shrubs and trees by YCC and CETA personnel between July and December 1978.

Along the north side of the entrance road to Masso, trees have been planted on the slope down from Spruance Drive which is the northern boundary of the park. Throughout this area, 240 coffee trees (scientific names are in a list at the end) were planted. In the long narrow portion starting at the west entrance, coffee trees were planted under the existing African tulip trees. The rest were planted under the acacia, eucalytpus and mahogany trees. These larger trees were planted where the entrance widened, so they would not interfere with the power lines. Eight acacia trees were planted west of the 60 eucalyptus trees which are west of the 70 mahogany seedlings that end where the clearing of tangan-tangan was stopped. East of the mahogany planting and under the tangan-tangan, 87 ifil seedlings were planted. These extend to just east of the sluice gate; then 10 seedlings each of super tangan-tangan and guanacaste were planted in the area along the pond's edge. Along Spruance Drive, and above this area, 5 monkey pod trees were planted.

Along the south side of the entrance road, 12 eucalyptus were planted adjacent to the tangan-tangan. On the hill between power poles 3 & 4 are 3 large concrete platforms; 6 monkey pod trees were planted here and 10 more along the hillside east toward power pole 5. Between power pole 3 & 7 are planted 80 giant orchid and 25 white orchid parallel to the road. Twenty-five Venezulean shower trees were planted amongst the orchid trees in the area around power pole 5. West of power pole 5 across a small ravine are 6 acacia and some monkey pod. Above power pole 5 are planted 25 potato trees and 40 gmelina which extend both higher and southeast of this area. In the area above power pole 7, about 40 ifil seedlings were planted amongst the tangan-tangan. Between power poles 5 & 7 were planted 15 madre de cacao seedlings.

In the grassy areas between power poles 7 & 8 and southwest of the fire-foot trail were planted an assortment of trees including some Norfolk pines, mango, palomyria, talisai (tropical almond), guanacaste, and bay rum trees planted by a YCC crew. Also, planted in the area, were 34 paperbark, 15 tropical almond, 2 black tropical almond, Siam redbead, Ghana sensitive trees, and one phalsa cherry. Higher up the hillside, 12 monkey pod trees were planted.

North of power pole 7, longan and one avocado were planted. Along the foot trail leading down to the stream are a variety of trees. Near the top on the slope above the trail are growing one Mexican serviceberry and a Ceylon snake tree and further along are some jacaranda. Near the royal palm groves are planted some mango trees and on the hillside above the "YCC hut" are some bay rum trees.

Going uphill on the fire-foot trail, from power pole 7, the east side has 10 Siam redbead and on the west side are 5 Ghana sensitive trees. At this point, the trail starts to descend and near the left turn is an intermittent stream. On the north side of this stream are 25 Pride of India trees, many of which were eaten by snails. Between this stream and the next gully, were planted 10 Cochin sindora. Beyond this gully are planted algaroba. From this point, most of the area between the trail and the river was planted with 131 ecualyptus. On the south side of this trail, and extending north-west up the steep hill, are 84 acacia. Between the ecualyptus and the royal palm grove are planted 39 gmelina trees.

On the east side of the south Masso River and near the first waterfall is a fruit grove. Planted here are 6 cashews, 2 longan, 2 lychees, guavas and 1 mango. Further along the river in selected areas of good soil are more avocado and mango trees. Above the first falls, one follows the river southwest, east, south and then east again. In this last portion is another fruit grove dominated by longan trees. Back by the first waterfall, a small stream flows west into the river and this forms a deep gully that divides the eastern upland area. Along this area above the fruit grove are 20 Spanish cedar, and at the top are 3 or 4 guanacaste. Below and south of this area are planted 25 podocarpus trees.

On the north side of this small stream, and in the area above the YCC bridge, are planted 53 mahogany trees. At the top of this hill and south and south-east of power pole 9, Norfolk pines and royal palms were planted by YCC. Some pines are under the power lines and will need to be watched in the future.

North of power pole 9 is a ridge. Along the top of this ridge, 20 guanacaste were planted. On the lower northwest side of this hill and extending down toward the river and north of the check (erosion) dams are planted 23 tigers claw. On the northeast, east and southeast side of this same ridge are planted 30 narra trees, some of which may be on the northwest side also. Below the ridge and east of power pole 9 an old YCC trail starts that leads northeast into the hills. At the start of this trail, 20 bay rum were planted. North northeast of the hill by power pole 9 and across an intermittent stream is a hill or ridge. Ten guanacaste and 30 narra trees were planted on the west side of this hill before it descends steeply. Northeast of this planting, the ridge descends sharply and then flattens out. The flat area is large and slopes gently toward the west. Its north and east sides, however, drop off very sharply to the North Masso River below. Along the top of this steep slope were planted tuba tuba cuttings and as it levels off, 200 ironwood were planted in 2 or 3 rows along the northeast ridge. Southwest of these ironwood, 200 palomyria were planted in 2 to 4 rows. Southeast of these trees beginning in the flat area and continuing up the slope of the aforementioned hill are 200-300 sweet gum seedlings. On the ridge and southeast of the sweet gum, 72 Norfolk pines were planted.

The central portion of land between the two rivers finally ends in a peninsula jutting into the pond. On the penisular ridge and nearest the reservoir are planted 80 kapok trees. Further east and up the ridge are several narra trees that were planted 2 or 3 years earlier. On the south side of this ridge and below the kapok, several coconut seedlings and 50-75 eucalyptus trees were planted. Further to the southeast in a more level area near the *Phragmites* grass, some longan fruit trees were planted. More fruit trees including mango, avocado, guava and longan were planted at the western end of the ridge where construction took place.

Around the reservoir, below it and along the entrance road, many ornamentals plus fruit trees and other trees were planted. Of special interest is the rare *Serianthes nelsonii*. It is located near power pole 2 in the level area between Spruance Drive and the road that leads down into the park.

Individuals of various tree species are planted in different locations throughout the Masso area. Some of these were planted by the YCC people, others by CETA. Until the first dry season has passed, it will be difficult to determine just what will be growing in the future. Provided fires do not pass through the area in 1979, fertilizing and weeding during the summer of 1979 will be most helpful.

Prepared by: Greg Gordon and R. Logan Kock

COMMON & SCIENTIFIC NAMES
OF THE
TREES IN THE PLANTING REPORT

acacia - *Acacia confusa* & *A. ariculaeformis* & *A. magium*

African tulip trees - *Spathodea campanulata*

Algaroba - *Prosopsis pallida*

avocado - *Persea americana*

bay rum - *Pimenta racemosa*

cashew - *Anacardium occidentale*

Ceylon snake tree - *Wrightia tomentosa*

coconut - *Cocos nucifera*

coffee - *Coffea arabica* & *Coffea liberica*

Cochin sindora - *Sindora cochencinensis*

Cutch tree - *Acacia catechu*

ebony - *Diospyros ebenum*

eucalyptus - *Eucalyptus spp.*

Ghana sensitive tree - *Tetrapleura tetraptera*

gmelina - *Gmelina arborea*

guanacaste - *Enterolobium cyclocarpum*

guava - *Psidium guajava*

ifil - *Intsia bijuga*

ironwood - *Casuarina equisetifolia*

jacaranda - *Jacaranda mimosifolia*

kapok - *Ceiba pentandra*

longan - *Euphoria longan*

lychee - *Litchi chinensis*

madre de cacao - *Gliricidia sepium*

mahogany - *Swientenia macrophylla*

mango - *Mangifera indica*

Mexican serviceberry - *Amelanchier denticulatum*

monkeypod - *Samanea saman*

narra - *Pterocarpus indicus*

Norfolk pine - *Araucaria excelsa*

orchid (giant) - *Bauhinia tomentosa*

orchid (white) - *Bauhinia acuminata*

palomyria - *Callophyllum inophyllum*

paperbark - *Melaleuca leucadendron*

phalsa cherry - *Grewia tenax*

podocarpus - *Podocarpus neriifolius*

potato tree - *Salanum macranthum*

Pride of India - *Melia azedarach*

Royal palm - *Roystonea elata*

sandalwood - *Santalum album*

Siam red bead - *Adenanthera microsperma*

Spanish cedar - *Cedrela odorata*

super tangan - tangan - *Leucaena leucocephala*

sweet gum - *Liguidambar styraciflua*

talisai (tropical almond) - *Terminalia catappa*

tigers claw - *Erythrina varigata*

tuba tuba - *Jatropha curcas*

Tropical almond - *Terminalia corticosa*

Tropical almond (black) - *Terminalia melanocarpa*

Venezulean shower - *Cassia sp.*

wedelia - *Wedelia biflora*

APPENDIX B
MASSO RESERVOIR DEVELOPMENT

Contents

A. Unsolicited letter of support from Robert L. Haddock, member of Guam Animal Import Screening Committee, dated 26 November 1979.

B. U.S. Fish and Wildlife Service letter from E.B. Chamberlain, Jr. to Harry T. Kami, dated 10 October 1979.

C. Aquatic and Wildlife Resources Division letter from Harry T. Kami to David B. Marshall, dated 15 June 1979.

D. U.S. Fish and Wildlife Service letter from David B. Marshall to Harry T. Kami, dated 30 May 1979.

E. U.S. Fish and Wildlife Service letter from E.B. Chamberlain, Jr. to Harry T. Kami, dated 28 March 1979.

F. Draft Environmental Impact Statement prepared by Aquatic and Wildlife Resources Division and submitted to the U.S. Fish and Wildlife Service.

G. Executive Order 11987 of 24 May 1977 concerning the introduction of exotic species into the United States.

GOVERNMENT OF GUAM

AGANA

26 NOV 1979

Memorandum

To: Chief, Aquatic and Wildlife Resources

From: Public Health Veterinarian

Subject: Masso Reservoir Project

For the record, I would like to state my views on the proposed introduction of exotic fish species to the Masso Reservoir.

1. Since the type of multi-species release proposed apparently has not been studied before, I believe the recommendations of the members of your staff who have evaluated the program are as valid as those of any off-island experts who have not had any more experience with the problem at hand than your staff has. The opinions of "experts" will be based on their experience or knowledge of dissimilar situations and will probably not be valid with respect to the Guam problem.

2. While concern for the protection of native species is currently in vogue and admirable, the proposed introduction will be made in an artificially created ecological niche not naturally present on Guam and species adapted to this environment would not compete with endemic species. Therefore I don't believe this is a valid objection.

3. While the recreational value of sport fishing at Masso may always be marginal, the Ugum Reservoir project has very significant potential in this respect. If the proposed release program is not

evaluated now under the nearly ideal situation available at Masso, many years will be lost in determining the correct program to follow at Ugum.

In summary, I believe you should proceed with the release program proposed by your staff. I do not believe that objections presented thus far have sufficient merit to warrant halting the program.

Bob Haddock

ROBERT L. HADDOCK, DVM, MPH

United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

October 10, 1979

In reply refer to:
AFA-FA Guam F-2-D
Guam F-2-D-2

Mr. Harry T. Kami, Chief
Aquatic and Wildlife Resources Division
Department of Agriculture
Box 23367, GMF
Guam, M.I. 96921

Dear Mr. Kami:

Attached are copies of the approved Amendment No. 2 to the Application for Federal Assistance (AFA) of Dingell-Johnson Project F-2-D, Renovation of Masso Reservoir and conditionally approved documents for AFA Amendment No. 3 and Project Agreement F-2-D-2. As you will note, we have placed conditions regarding Work Item 18-Stocking, and Work Items 10d and 10e-Artificial Reefs and Fish Attractors on these documents.

Based on comments we received from several fishery biologists who reviewed your draft document entitled "Environmental Impact Statement for the Introduction of Exotic Fishes Into Masso Reservoir," it is obvious that the proposed stocking of exotics is a controversial issue. In addition, Section 2(a) of Executive Order 11987, Exotic Organisms, May 24, 1977 instructs Federal agencies to restrict the introduction of exotic species into the natural ecosystem and to encourage States and local governments to prevent such introduction. In view of this, it is our conclusion that before funding of the proposed stocking of exotic fishes can be given further consideration preparation and circulation of a formal Environmental Impact Statement in accordance with provisions set forth by the National Environmental Policy Act (P.L. 91-190) and the related Council on Environmental Quality Regulations (Federal Register Nov. 29, 1978) will be necessary. This NEPA procedure will be a lengthy and expensive process for your agency and ours. To complete the process your office will be required to provide all the needed information for such a document. The overall cost for a completed EIS will far exceed the $750.00 amount proposed for stocking of exotic species in Masso Reservoir. It does not appear to be a wise use of funds which could be better spent to benefit the Guam resources and resource users. We continue to feel an attempt to provide recreational fishing with native species or exotic species already established in Guam would be more consistent with sound resource management than to introduce additional exotics which might become established.

As previously stated in our August 17, 1979 letter the Environmental Assessment covering the marine habitat enhancement activities needs to be strengthened with the following information: (1) a description of the proposed artificial reefs including types of material to be used, size of the reefs, distribution, and total number to be built; (2) physical descriptions of the attractors and aggregating devices, the total number of attractors and aggregators planned, and distribution of these devices; (3) physical changes which will occur as a result of artificial reef construction and biological changes which are created from establishment of reefs, midwater attractors, and aggregating devices and (4) the anticipated impact on both resident and pelagic fish populations resulting from the greater harvest which will occur with congregation of the fishes.

Work Item 10a-Clearing is approved with the understanding that conditions in 1981-82, when the activity would actually take place, may dictate that the additional clearing is not justified. Whether approval for funding the additional clearing of vegetation can be given at that time will depend upon the type fishery established in Masso Reservoir and the need for additional open water area.

The remaining activities in the documents are approved as they were proposed.

If you have any questions relating to your Fisheries Development Project, please feel free to contact our office.

Sincerely yours,

E.B. Chamberlain

E.B. Chamberlain, Jr.
Assistant Regional Director
Federal Assistance

Attachments

June 15, 1979

Mr. David B. Marshall
U.S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 NE Multnomah St.
Portland, Oregon 97232

Dear Mr. Marshall:

In reply to your letter of 30 May 79, we still believe that in order to complete the renovation of Masso Reservoir into a pond for public freshwater recreational fishing, we must introduce exotic species of fish. You raised a number of questions concerning our proposal, and each will be answered specifically below.

1. Escape and Establishment: We refer you to page 3, paragraph 2 of the EIS, where we pointed out that almost all of the exotic species we propose to stock are on-island today and commonly available through aquarium shops, and therefore, the danger of escape and establishment will remain regardless of what we do. As we stated, several exotic species have already been introduced into a pond in northern Guam by aquarium enthusiasts. One advantage of allowing us to proceed in Masso Reservoir is that the introduction will be in a relatively controlled situation, rather than totally by chance. Also, as we pointed out on page 2, paragraph 5, the fish we propose to stock are specifically adapted to a standing water environment and are not found in fast-flowing streams. Virtually all of Guam's streams are steep and fast-flowing and do not provide suitable habitat for these species to become established. In fact, there are no natural lakes or ponds of any significance on Guam, and therefore there are no local fish specifically adapted to live in such an environment. The fish we propose to stock will be colonizing primarily man-made habitats.

2. Effects on Native Species: We expect some reduction in the populations of native species above and below the Masso Reservoir; however the exotics will not colonize the entire stream and native species will retain a refuge free from

competition and predation in the upper reaches above the waterfalls. There is virtually no chance the exotics will cause the extinction of any native species (we have no endemics) since the exotics are standing water species and will not be able to colonize most of our streams at all.

3. *Eradication:* Should it prove necessary to eradicate the exotics, the Masso system is small enough that it would be possible by the application of rotenone in the streams and reservoir. Application would probably be necessary only below the waterfalls, and thus native stocks would be preserved to re-populate the system. Even if it proved necessary to apply rotenone above the waterfalls, there is no organism that is endemic to the Masso system, and all native species could be re-introduced from other streams.

4. *Diseases and Parasites:* In order to prevent the introduction of any exotic diseases or parasites, the imported fish shall all be treated with formalin (200 ppm) or copper sulfate (0.5 - 1.0 ppm) for 45 minutes prior to stocking. Of course any obviously diseased fish shall be destroyed by burning.

5. *Use of Native Fish by the Guamanian People:* We have no statistics on the use of freshwater fish by the local people; however, we do know that the shrimp *Macrobrachium lar* and the eels *Anguilla marmorata* and *A. bicolor* are taken with traps and nets. There is no freshwater fishing with hook and line. Occasionally *Awaous guamensis* and *Eleotris fusca* are caught incidentally and are kept, but they are never specifically fished for. Freshwater fishing pressure is generally very low.

6. *Desirable Freshwater Fish:* None of the native species of fish is especially desirable to the extent that it is heavily exploited. Military personnel occasionally fish for the tucunare below the Fena dam, and the Filipinos occassionally fish the streams for tilapia.

7. *Fena Reservoir:* The problem in Fena Reservoir is that the populations of introduced species are totally out of balance, similar to the perennial problems with bass-bluegill stockings in the U.S. Fishing pressure on Fena is very low because the reservoir is on restricted military property (Naval Magazine), and the public is not allowed.

8. *Losses and Gains:* Considering that there is virtually no recreational freshwater fishing on the island at present, the establishment of a fishery would certainly be a gain. The reason there is no fishery at present is that *there are no suitable sport fish.*

9. Other Possibilities: The fish currently found in Fena Reservoir are not suitable for stocking in Masso Reservoir. The tucunare is extremely aggressive during its spawning season and will take a bare hook. In a pond the size of Masso (2 acres) it could easily be fished out. The tilapia is considered little better than a trash fish by the local people, and any attempt to develop a tilapia fishery would almost certainly fail. If we were to stock tucunare and tilapia together as in Fena, we may also have the same unbalanced system. In Fena the tucunare are so voracious that they have kept the tilapia and other forage species at a low level, and have developed a stunted population themselves. As stated in our EIS, we do not wish to duplicate our earlier mistake.

There are no suitable native freshwater fish to establish a fishery. The exotics in Fena Reservoir are unsatisfactory. Temperate species such as channel catfish, largemouth bass and bluegills have been unsuccessfully introduced. If we are to have a freshwater fish pond in Masso Reservoir, it will have to be stocked with exotics of a variety that can survive here.

Sincerely,

HARRY T. KAMI
Chief, Aquatic & Wildlife
Resources

United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

May 30, 1979

In reply refer to:
AFA-FA

Mr. Harry T. Kami, Chief
Aquatic and Wildlife Resources Division
Department of Agriculture
Box 23367, GMF
Guam, M.I. 96921

Dear Mr. Kami:

After having reviewed your Draft EIS for Introduction of Exotic Fish Into Masso Reservoir and received comments on the document we have many questions and a number of suggestions. Based on the review we believe that the Draft has failed to consider a number of important aspects of such a proposal and the proposal itself may be highly questionable.

One very important subject which was treated quite lightly in the Draft is the matter of escape and establishment of exotic fish elsewhere. Based on known examples of unwanted introductions of fish and other aquatic animals from one area or watershed to another it appears highly probable that exotics would become established in other watersheds on Guam. If this were to happen what effect would it have on native species of fish and other organisms? What diseases and parasites might be introduced with the exotics to possibly be spread throughout the island? If eradication were attempted would it be more destructive to the native species than to the exotics? Are any of the native fishes and invertebrates which might be affected by the introduction endemic to Guam and if so could the introduction result in their extinction?

Consideration must also be given to the value of those native and established fish and other aquatic organisms which could be threatened by the introduction of exotics. To what degree do the Guamanian people presently make use of the native freshwater fishes and invertebrates? Do the people find any of the freshwater fish presently in Guam particularily desirable? Does part of the problem at Fena Reservoir result from too much fishing for a highly valued species present in the reservoir? Would the overall losses be greater than the gains in the event that a fishery could be established with exotic fishes?

We believe answers to the foregoing questions must be known before you proceed with your proposal for the introduction of exotic species. We also believe all other possibilities for establishing a fishery at Masso Reservoir should first be exhausted. It seems likely to us that some fishes presently found on Guam could be used to establish and maintain a sport fishery. Species of fish found in Fena Reservoir may with intensive management be a choice for Masso even though there appears to be some problem with the combination of fishes or conditions at Fena. Perhaps your *Awaous guamensis*, a goby similar to a prized recreational fish in Hawaii should be considered. Other fishes already present in Guam's waters might be used for establishment of a successful fishery in Masso Reservoir without posing a threat to the island's aquatic ecosystems. To avoid this threat and the many problems which can be associated with the introduction of exotics we are hopeful that you can successfully establish a fishery in Masso Reservoir with species of fish already found on Guam.

If you have any questions relating to our review of the proposal for establishment of a fishery in Masso Reservoir please feel free to contact our office.

Sincerely yours,

David B Marshall

David B. Marshall
Acting Assistant Regional Director
Federal Assistance

United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

March 28, 1979

In reply refer to:
AFA-FA

Mr. Harry T. Kami, Chief
Aquatic and Wildlife Resources Division
Department of Agriculture
Box 23367, GMF
Guam, M.I. 96921

Dear Mr. Kami:

We have received and are reviewing your draft Environmental Impact Statement covering the proposal to introduce exotic fish species into Masso Reservoir.

Because of the many examples of ecological problems which have resulted from past introductions of exotic species in various parts of the world any proposal for new introductions into natural ecosystems merits close scrutiny. Under Executive Order 11987 dated May 24, 1977, executive agencies are directed, to the extent permitted by law, to encourage the States, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems. Before such an introduction can be approved there must be a finding that it will not have an adverse effect on natural ecosystems. Because of this and to obtain as much information on the subject as reasonably possible, we are having your draft statement reviewed by individuals from outside the Service as well as by other personnel within our Service.

These reviews may cause some delay in your plans to establish a sport fishery in Masso Reservoir; however, it is essential that we do everything possible to insure protection of the natural ecosystems. If you have any questions relating to this matter please feel free to contact our office.

Sincerely yours,

E.B. Chamberlain, Jr.
Assistant Regional Director
Federal Assistance

BACKGROUND:

Guam is a tropical island of about 210 square miles located at 13°30' north and 144°45' east. The northern half of the island is a relatively flat raised limestone plateau, while the southern portion is primarily volcanic mountains. The Masso Reservoir is located in Piti Municipality in the central part of Guam where both limestone and volcanic soils occur (Figures 1 and 2).

The Masso Reservoir was originally constructed for use as a potable water reservoir in the early 1940's. By 1951 it had silted in to such an extent that it was abandoned, and subsequently became largely overgrown by *Phragmites karka*, a wetland grass. grass. The Division of Aquatic and Wildlife Resources conceived the idea of removing the *Phragmites* and developing the reservoir into a freshwater recreational fishing pond. Approximately one hectare of water surface has been cleared (see photos), and planned additional clearing should create a pond of about two hectares in size. The Department of Parks and Recreation has plans to install picnic facilities in the area once the pond is ready for use.

PROJECT DESCRIPTION:

The project is designed to create a public freshwater recreational fishing area in the abandoned Masso Reservoir. The project's name is the Masso Reservoir Rehabilitation Project. Part of the rehabilitation has involved construction work for which an EIS was prepared. It is now necessary to import exotic species of freshwater fish to stock in the reservoir. A table of those fishes approved for import by Guam's Animal Import Screening Committee is included as Appendix I at the end of this EIS.

The Masso Reservoir watershed consists of approximately two square kilometers of a predominantly upland swordgrass community. Two small feeder streams flow into the reservoir. They are one and two kilometers long respectively for the southern and northern branches. The stream beds are one to three meters in width, with pools up to 1.5 meters deep. There are no available data on the stream discharge rates above or below the reservoir.

Below the reservoir the Masso River flows for about one kilometer to the ocean. A portion runs through a residential area, and most of it has been or is now subject to various types and degrees of pollution.

The Masso Reservoir presently has a surface area of about 1 hectare and a rather uniform depth of 2 meters. Additional construction work will expand the surface area by about one hectare. The bottom is a soft unconsolidated mixture of silt and clay. The slopes and shallow areas are compacted and have *Chara* sp. and other aquatic plants growing on them.

A limited variety of aquatic faunal organisms are found in the reservoir and the two feeder streams. The invertebrates include the large shrimp *Macrobrachium lar*, smaller shrimps of the genera *Atya* and *Caridinia*, and the mollusc *Neritina pulligera*. The fishes include the eels *Anguilla marmorata* and *A. bicolor*, the gobies *Chonophorus guamensis*, *Sicyopterus macrostetholepis* and *Microsicydium elegans*, an eleotrid, *Eleotris fusca*, and an introduced catfish, Clarias batrachus.

LAND USE RELATIONSHIPS:

The Masso Reservoir and contiguous land is owned by the U.S. Navy. A land use agreement (in perpetuity) has been secured with the Navy. Under the terms of the agreement with the Navy and the U.S. Fish and Wildlife Service, the Department of Agriculture is responsible for the conservation and management of the fish, wildlife, and recreational resources in the Masso area. Most of the watershed is owned by the Government of Guam, and has been zoned as conservation land to be managed by the Department of Agriculture.

The abandoned reservoir is to be developed into a freshwater recreational fishing pond for the general public. The Department of Parks and Recreation will construct picnic facilities around the pond. The watershed is to be reforested and will eventually provide a large recreational area suitable for hiking and camping.

There are no conflicts between the land use plan and the cooperative agreement. Development of a recreational fishing pond with a surrounding forest and picnic facilities is compatible with the area's designation as conservation land. There are no conflicts between these plans and the Clean Air Act or the Federal Water Pollution Control Act.

PROBABLE IMPACT OF THE PROPOSED ACTION ON THE ENVIRONMENT:

This action will result in the establishment of selected species of exotic fish in Masso Reservoir. It is also possible that some exotic species may move upstream or downstream from the reservoir; however, all the exotic fishes selected are adapted to live in lentic environment of standing or slowly moving water. Small waterfalls in both feeder streams should provide effective barriers to upstream migration; and observations on Guam show that waterfalls have acted as effective barriers to Tilapia mossambica and Kuhlia rupestris (Kami, et. al.). Upstream migration will be limited to about 200 meters for the south branch and one kilometer for the north branch.

The primary positive effect of stocking exotic fishes will be the establishment of populations which will provide recreational freshwater fishing where none now exists. An important secondary gain will be the information gathered from monitoring the reservoir and streams. This information will be used to determine which combinations of exotic fishes are best suited to stock other reservoirs, and the likely effect on the resident aquatic organisms.

A primary negative effect of stocking exotics will be to increase the competition in the reservoir and streams, which will locally reduce the numbers of indigenous shrimps and fishes. This is not expected to result in the demise of any individual species. A sampling program for both streams has been initiated in an effort to better determine the extent to which the populations of indigenous species are affected subsequent to the introductions.

A secondary negative effect of some concern is the possibility that people might remove live fish from the pond and introduce them to other streams and rivers. Signs will be posted prohibiting such action, but enforcement may be difficult. Fortunately, none of the larger river systems are located close to the Masso area. Also Guam's rivers are short, fast flowing streams, subject to periodic flooding. At best they would provide only marginal habitat for the reproduction and survival of the exotic species, and many would probably not survive in them. It should be further noted that most of the exotic species to be introduced are common aquarium fishes, and there is already the possibility that some of these same fish have been or will be introduced by aquarium enthusiasts. In fact, there is one isolated pond in northern Guam which contains mollies, guppies and swordtails already. Information gained through monitoring the Masso streams would allow us to respond more properly to potentially damaging accidental introductions elsewhere.

Finally, providing a recreational fishing area will result in more people utilizing the Masso Reservoir and adjacent areas, which will inevitably increase the amount of trash deposited in the area. This can be mitigated through proper park supervision and maintenance.

ALTERNATIVES TO THE PROPOSED ACTION:

There are two alternatives to the proposed action of stocking exotic fish in Masso Reservoir. They are: not to stock the pond, or to use fish already resident in streams or lakes on Guam. Not stocking the pond would defeat our original purpose of rehabilitating the reservoir into a recreational fishing pond. Those species of eels, gobies and shrimp presently resident in the pond may increase in numbers, but that would not benefit the fishing public a great deal.

It would be possible to stock species of fish already found on Guam. The species available include the mosquito fish (*Gambusia affinis*), the tilapia (*Tilapia mossambica*), and the tucunare (*Chicla ocellaris*). All three species are previously introduced exotics, and have been stocked in Fena Lake, a reservoir with a surface area of about 71 hectares. However, the Fena Lake system is very much out of balance, as evidenced by the reduction in average size of tucunare caught by sport fishermen from 3 pounds (maximum of 6 pounds) to about 3/4 of a pound (with 1½ pounds considered large).

In choosing which exotic species to stock, a number of considerations must be taken into account, including climate, habitat and spawning requirements, availability for stocking, and possible ecological consequences. As pointed out during the first international Symposium on Predator-Prey Systems in Fish Communities and Their Role in Fisheries Management, "Mixing of geographical races of fish can lead to . . . predator-prey relationships that can thwart fishery management goals," (McCammon and Von Geldern, 1978). For this reason, we intend to stock fish from a single geographical region, specifically the Mekong River System of Southeast Asia. Currently Fena Lake is stocked with fish introduced from two continents; the system is very much out of balance, and we do not wish to repeat our mistake.

Our first introductions to Fena Lake included the temperate North American largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*), and channel catfish (Ictalurus punctatus). The bass grew to adult size, but failed to reproduce, and the channel catfish were never seen after they were stocked. As a result of this experience, we have decided not to stock species from temperate climates.

We have chosen Southeast Asia as our source of exotics for a number of reasons. There are over 600 species of fish from which to choose that are found in the Mekong River system alone. Local pet stores stock a wide variety of Southeast Asian fish, and their suppliers have indicated that they can get us additional species not normally for sale. Conditions on Guam closely approximate those in Southeast Asia in terms of climate and general water regimes; and the fish should have little trouble adapting to Guam and reproducing here.

There are many habitats in Fena Lake that remain unoccupied, and the low fish species diversity is felt to be a significant contributing factor to the unbalanced predator-prey relationship found there. In order to avoid this situation in Masso Reservoir, we intend to stock a larger variety of fish. The species listed in Appendix II include those that prefer a muddy bottom, shallow vegetated areas, and open water; there are bubble nest builders, bottom nest builders, and some with adhesive eggs which stick to vegetation. Exactly how many species Masso Reservoir can support is debatable. In the Mekong River Basin, large reservoirs (200 km^2) typically support 80 or more species of fish. We feel that Masso Reservoir, small as it is, could probably support populations of at least 15-20 species, if the species mix is right. Most of the species in Appendix I are small and well suited to a Masso type environment. Ideally, all the introduced species will survive. However, if a few do not make it, those that do survive should represent the best and most stable mix possible from among the introductions.

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED:

Reductions in populations of resident aquatic organisms in the Masso Reservoir will be unavoidable with the introduction of exotic species. To the extent that the exotic fishes move up the feeder streams, populations of resident organisms are likely to decrease there as well. It is anticipated that upstream migration will be limited to that portion of each stream below its first small waterfall.

Below the reservoir, exotic species will probably have some adverse effect on the resident organisms. This portion of the Masso River is not as pristine as the streams above the reservoir, and Tilapia mossambica and Kuhlia rupestris are both found there. Kuhlia preys heavily on the native river organisms, and Tilapia competes with them for food and habitat; all of this results in low population levels among the shrimp, goby and eleotrid populations. Exotic forage fishes will be preyed upon by the Kuhlia, but in turn exotics will compete with gobies, eleotrids, and the more populous Tilapia. If Hampala dispar establishes itself, it will prey on the exotic and resident organisms, compete with the Kuhlia for food, and possibly even prey upon the Kuhlia. The major impact is likely to be a change in the relative abundance of Tilapia mossambica, a previously introduced exotic fish, and Kuhlia rupestris, a euryhaline fish.

Juvenile recruitment of some resident fishes and shrimps in the reservoir and streams is likely to be reduced as a result of the introduction of exotic fishes. The eggs of some resident species float downstream to hatch, and they live out their early life stages in the estuarine conditions near the river mouth. As juveniles they must migrate upstream through the reservoir and back into the feeder streams. The juveniles will probably be preyed upon by the exotic fishes in the reservoir. This appears to happen in Fena Lake, where observations of the feeder streams indicate a higher proportion of adult versus juvenile fishes and shrimps compared to other similar streams on Guam. Predation on juveniles is at least marginally detrimental, yet predation on juveniles has not appeared to reduce the population of fishes and shrimps to such an extent that they cannot maintain their presence in the streams.

The Masso Reservoir watershed is such a small closed system that it seems to lend itself very well to the experimental introduction of exotic species. Monitoring of the feeder streams will give an indication of the interaction between the indigenous and introduced species in the system. If one or more of the exotic species appears to constitute a threat to the indigenous species of Guam, that affected portion of the Masso River and Reservoir could be treated to eliminate the undesirable species. Information gained will make it possible to more safely stock any future reservoir, or to better manage Fena Lake Reservoir. Detrimental effects from stocking Masso Reservoir can be more easily rectified than if they occurred in one of the larger river systems of Guam.

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY:

The immediate benefit of introducing exotic fishes will be the establishment of a recreational freshwater fishing pond for the people of Guam (no such pond now exists). A long term loss will result through the reduction in the numbers of naturally occurring fishes and shrimps in the streams and reservoir as a result of direct competition with the exotic species, and increased predation on juveniles. If any of the exotic fishes competes with or preys heavily on the native shrimps and fishes, its introduction into other rivers on Guam could represent another long term loss. If the monitoring program should indicate such a potential problem, steps would be taken to eliminate the exotic species while it was still confined to the Masso River system.

A long-term environmental gain will be in the gathering of information regarding the relationship between the introduced exotic fishes and the native fishes found in the feeder streams of Masso Reservoir. Knowledge will also be gained of the relationship among the exotics themselves with regard to predator-prey interactions and habitat and resource partitioning. No short-term losses to the environment are anticipated.

IRREVERSIBLE AND IRRETRIVABLE COMMITMENTS OF RESOURCES:

The unavoidable impact of introducing exotic fishes will be the anticipated reduction in the numbers of native fishes and shrimps found in the Masso Reservoir and feeder streams. Small waterfalls in the feeder streams should act as barriers to the exotic fishes so that the upper reaches of these streams will contain only native fishes. Monitoring of the streams will determine if this is indeed the situation that develops.

If portions of the Masso River system remain free of exotics, there will be no irreversible losses involved. Poisoning of those portions of the streams and reservoir containing exotic species would eliminate all species from the system. Reproduction by native fishes and shrimps in the untreated upper reaches of the streams would eventually result in their reestablishment throughout the system.

OTHER INTERESTS AND CONSIDERATIONS OF FEDERAL POLICY THAT OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION:

Stocking of forage fishes from Southeast Asia in the Masso Reservoir will be a major step toward the establishment of a freshwater fish pond on Guam that is open to the general public. In addition, information regarding the dynamic relationships between the resident and exotic species will be gathered. This should prove extremely valuable to the Division in the future. Guam's only lake now is Fena Reservoir on restricted military property. The relationship between game fish and forage fish in Fena Lake is out of balance, and information from the Masso Reservoir may give us insights into possible ways of remedying this situation.

At this time, hearings are being conducted and requests are being made by government officials that another reservoir be built for the civilian community of Guam. When and where this reservoir will be built is uncertain, but its construction seems inevitable. This reservoir will be open to the public for fishing. The experience of stocking and managing the Masso Reservoir will provide data which have not been available from Fena, and this may prevent a repetition of the Fena situation. It is likely that disgruntled local fisherman might decide to do their own stocking of the new reservoir with locally-available exotic fishes if the "Fena situation" should occur, and this should certainly be forestalled.

The Masso River watershed is small compared with the Fena Lake watershed. A disruptive exotic in the larger watersheds of Guam would be difficult to eradicate once it became established. If we are to establish freshwater sport fishing on Guam using Southeast Asian species, then Masso Reservoir is the logical place to begin. Of the available aquatic systems on Guam, it is the easiest to monitor and control without the danger of exotics spreading naturally into larger river systems.

APPENDIX I

Species List Approved by the Guam Animal Import Screening Committee for Importing and Stocking in Masso Reservoir.

Trichogaster trichopterus - 3 spot gourami
T. pectoralis - snake skin gourami
Trichopsis vittatus - croaking gourami
Ctenops schalleri - croaking gourami
Acanthophthalmus kuhlii - coolie loach
Lepidocephalus octocirrhis - loach
Noemochelius fasciatus - loach
Hampala dispar
H. macrolepidota
Pristolepis fasciata
Aplocheilus panchax - blue panchax
Demogenys pusellus - wrestling halfbeak
Brachydanio albolineatus - pearl danio
Esomus metallicus - Flying barb
E. malayensis - Malayan flying barb
Puntius partipentazona - tiger barb
P. fasciatus - striped barb
P. lineatus - striped barb
P. leiacanthus
Barbodes pentazona - 5 banded barb
Capoeta tetrazona - tiger barb
Chanda siamensis - glass fish
Osteochilus hasseltii - hard lipped barb
O. vittatus - hard lipped barb
Rasbora heteromorpha - harlequin rasbora
R. trilineata - scissor-tail rasbora
R. maculata - dwarf rasbora
R. borapetensis
Notopterus notopterus - feather back
Botia macracantha - clown loach

APPENDIX 2

Species List of Fishes to be Stocked in Masso Reservoir.

For each species, the common name, maximum size, food, method of reproduction, and area of origin is listed if it is known.

Game Fishes

Hampala dispar - 12-15", it will be the largest carnivore in the pond.

Pristolepis fasciata - 10", omnivore, a "bluegill" type of fish.

Forage Fishes

Bottom feeders

Acanthophthalmus kuhli - coolie loach, 3½", scavenger, Southeast Asia.

Lepidocephalus octocirrhis - loach, 3", scavenger, spawns adhesive eggs in plant thickets, Southeast Asia.

Noemochelius fasciatus Bleeker - loach, 3½", scavenger, Thailand, Malaysia, Sumatra.

Surface feeders - open water

Aplocheilus panchax - blue panchax, 3", insect larvae and plankton, eggs attached to plants, Malay Peninsula.

Demogenys pusellus - wrestling halfbeak, 3", insect larvae and plankton, live bearer, Southeast Asia.

Surface feeders - vegetated edges

Brachydanio albolineatus - pearl danio, 3", insect larvae and plankton, eggs sink to bottom but laid among plants, schooling fish, Sumatra, Burma, Thailand.

Esomus metallicus - flying barb, 2½", insect larvae and plankton, semi-adhesive eggs laid among plants, Thailand, Malaysia.

All depths

Trichogaster trichopterus - 3 spot gourami, 6", omnivore, bubble nest builder, Southeast Asia.

Trichogaster pectoralis - snake skin gourami, 10" (not expected to grow this large in Masso), omnivore, bubble nest builder, Indochina, Thailand.

Trichopsis vittatus - croaking gourami, 2½", omnivore, bubble nest builder (prolific, but eggs sink), Malaysia, Thailand, Indochina.

Vegetated shallow areas

Puntius partipentazona - tiger barb, 2", herbivore, eggs scattered in vegetation, Thailand.

Puntius fasciatus - stripped barb, 5", eggs scattered in vegetation, Sumatra, Borneo.

Barbodes pentazona - 5 banded barb, 2", eggs scattered in vegetation, Malay Peninsula, Borneo.

Osteochilus hasseltii - hard lipped barb, 2", Malaysia, Thailand.

Chanda siamensis (cf. C. wolffii) - glass fish, 2" eggs adhere to plants, Thailand.

Slopes between vegetated shallows and pond bottom

Rasbora heteromorpha - harlequin rasbora, 2", omnivore, eggs attached to the underside of leaves, Malaysia, Thailand.

Rasbora trilineata - scissor tail rasbora, 8", omnivore, spawns among fine leaved plants, Thailand.

Rasbora maculata - dwarf rasbora, 1", omnivore, partially adhesive eggs layed among plants, Malay Peninsula.

Rasbora borapetensis - 1½", omnivore, Thailand.

List of Fish to be ordered if the first choice is not available:

Ctenops schalleri (for Trichopsis vittatus) - croaking gourami.

Capoeta tetrazona (for Puntius partipentazona) - tiger barb, 2½", omnivore, spawns in plant thickets, Sumatra, Borneo.

Puntius lineatus (for P. fasciatus) - striped barb.

Osteochilus vittatus (for O. hasseltii) - hard lipped barb, 2½", Thailand, Malaysia, Sumatra.

Esomus malayensis (for E. metallicus) - Malayan flying barb, 2", semi-adhesive eggs laid among floating plants, Malay Peninsula.

Fish + wildlife

RDA

MW

Title 3—The President

Executive Order 11987 May 24, 1977

EXOTIC ORGANISMS

By virtue of the authority vested in me by the Constitution and statutes of the United States of America, and as President of the United States of America, in furtherance of the purposes and policies of the Lacey Act (18 U.S.C. 42) and the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.), it is hereby ordered as follows:

Section 1. As used in this Order:

(a) "United States" means all of the several States, the District of Columbia, the Commonwealth of Puerto Rico, American Samoa, the Virgin Islands, Guam, and the Trust Territory of the Pacific Islands.

(b) "Introduction" means the release, escape, or establishment of an exotic species into a natural ecosystem.

(c) "Exotic species" means all species of plants and animals not naturally occurring, either presently or historically, in any ecosystem of the United States.

(d) "Native species" means all species of plants and animals naturally occurring, either presently or historically, in any ecosystem of the United States.

Sec. 2. (a) Executive agencies shall, to the extent permitted by law, restrict the introduction of exotic species into the natural ecosystems on lands and waters which they own, lease, or hold for purposes of administration; and, shall encourage the States, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States.

(b) Executive agencies, to the extent they have been authorized by statute to restrict the importation of exotic species, shall restrict the introduction of exotic species into any natural ecosystem of the United States.

FEDERAL REGISTER, VOL 42, NO. 101—WEDNESDAY, MAY 25, 1977

(c) Executive agencies shall, to the extent permitted by law, restrict the use of Federal funds, programs, or authorities used to export native species for the purpose of introducing such species into ecosystems outside the United States where they do not naturally occur.

(d) This Order does not apply to the introduction of any exotic species, or the export of any native species, if the Secretary of Agriculture or the Secretary of the Interior finds that such introduction or exportation will not have an adverse effect on natural ecosystems.

Sec. 3. The Secretary of the Interior, in consultation with the Secretary of Agriculture and the heads of other appropriate agencies, shall develop and implement, by rule or regulation, a system to standardize and simplify the requirements, procedures and other activities appropriate for implementing the provisions of this Order. The Secretary of the Interior shall ensure that such rules or regulations are in accord with the performance by other agencies of those functions vested by law, including this Order, in such agencies.

Jimmy Carter

THE WHITE HOUSE,
May 24, 1977

[FR Doc.77-15120 Filed 5-24-77;1:41 pm]

Masso reservoir in final stages of renovation viewed from the east.

Masso reservoir before start of renovation.

Masso reservoir during renovation.

Masso sluice-gate before repair.

Masso sluice-gate and dam after construction.

Section IV

Aquaculture
(Public Law 88-309 Matching Funds)

Project Title:	Development of Polyculture Fish Farming Under Tropical Conditions
Period Covered:	October 1, 1978 through September 30, 1979
Funding Source:	National Marine Fisheries Service (Public Law 88-309) and Government of Guam

CONTENTS

INTRODUCTION:

Giant Malaysian Prawns and Chinese Carps

- Commercial Ponds
- Department of Agriculture
- Permanent Hatchery

Freshwater Eels

Soft-Shell Turtles

Tilapia

- Monosex Population Experiments
- Hybrid Orange Coloration

Pangasius Catfish

Fish Disease Training

Discussion and Recommendations

Literature Cited

INTRODUCTION

The Division of Aquatic and Wildlife Resources of the Department of Agriculture initiated investigation into the prospects of aquaculture on Guam in 1973. The initial phase of the program dealt with investigating the suitability of several species for culture on the island in experimental demonstration ponds located on the Talofofo River. Among the species examined were the Giant Malaysian prawn (*Macrobrachium rosenbergii*), freshwater eels (*Anguilla japonica* and *A. rostrata*), Chinese carps (*Hypophthalmichthys molitrix*, *Aristichthys nobilis*, *Ctenopharyngodon idella*), and hybrid tilapia (*Sarotheradon mossambicus* and *S. niloticus*). The species with the most promising results were the *Anguilla japonica* and *Macrobrachium rosenbergii* (FitzGerald & Nelson, 1979).

The second phase of the investigation consisted of assisting in establishing commercial ponds for culturing selected species, and providing extension services and technical support to the entrepreneur. These services have been continued into the present development phase by Department of Agriculture personnel, who are also working toward establishing a hatchery for prawns and other species on Guam. A hatchery is necessary for the island to become self-sufficient in the production of juveniles of the major cultured species with which to stock the ponds.

Today there is a small cottage industry of prawn farms; and eels, hybrid tilapia, and freshwater turtles are also being cultured on a small scale. The majority of the ponds are managed as polyculture systems with several species of Chinese carp cultured as secondary species. Research on some marine and freshwater species that may prove promising for aquaculture on Guam is being conducted at the University of Guam and at the Guam Department of Agriculture.

GIANT MALAYSIAN PRAWNS AND CHINESE CARPS

A. Commercial Ponds

Macrobrachium rosenbergii was first introduced to Guam in 1974 from Hawaii. The Anuenue Fisheries Research Center supplied post-larvae for the Guam Department of Agriculture's experimental and demonstration ponds, and, subsequently, to a few commercial ponds for a period of three years. Today three prawn farms remain in operation with ponds totalling four acres. Two of the farmers, Mr. Baza and Mr. Martinez, use a polyculture system with Chinese carp as the secondary species. Polyculture allows fuller utilization of the pond's productivity (Ryther, 1968) and produces a secondary marketable product.

The prawns have been marketed through the farmer's own retail store, or directly from the farm. Currently the wholesale price is $6.00/lb., and the demand still far exceeds the supply. The majority of the product is sold frozen; however, some prawns are marketed iced.

The market acceptance of the carps has been better than expected. Consumers have reacted favorably to the quality of both the grass and the bighead carp; but the silver carp has been less successful in gaining market acceptance. This follows the ratings of carp in Taiwan, where silver carp is also the least preferred.

Harvesting Macrobrachium rosenbergii from Commercial Pond

Beginning of a small seining operation.

As the seine net is pulled in, water is splashed along the banks to drive the prawns out of the grass and into the net.

Prawns captured in seine net. A day's harvest will yield approximately 200 lbs.

Prawns of marketable size. Under favorable conditions, prawns will grow to 22.5 centimeters in length and 125 grams in weight in seven months.

Although the records are incomplete, some information is available on the stocking and harvesting of prawns and carps in commercial ponds. The best information has come from the Baza-Champaco operation in Merizo. The available information on prawns is summarized briefly in Table 1. In addition to prawns, 880 silver and grass carp were stocked in Baza-Champaco's ponds on October 17, 1977, and an unknown number of bighead carp at a later date. Since those stockings, 550 carp have been harvested for a total of about 2,100 pounds.

Table 1. Stocking and harvesting history for prawns in three commercial operations.

COMMERCIAL OPERATION	NUMBER STOCKED	NUMBER HARVESTED	POUNDS HARVESTED
Baza-Champaco			
August 25, 1977 thru May 6, 1978	67,200	13,376	704
May 3, 1978	14,000		
May 17, 1978 thru July 16, 1978	7,000	7,695	405
September 1978 thru June 1979			780
July 10-11 1979		12,429	249
TOTAL	882,000	33,500	2,138
Flores			
1976	258,000		
May 31, 1978	22,750		
June 5, 1978	9,250		
TOTAL	290,000	?	?
Pedro's Farm (Martinez)			
September 10, 1976	114,000		
September 19, 1976	102,000		
August 25, 1977	60,000		
May 1978			died 170
June 1978			100
TOTAL	276,000	?	(?) 270

B. Department of Agriculture

Temporary Hatchery.

The original source of *M. rosenbergii* post-larvae, Hawaii's Anuenue Fisheries Research Center, stopped supplying Guam in 1977 due to the increased demand for post-larvae in Hawaii. Other alternative off-island sources of post-larvae (e.g. the Micronesian Mariculture Center in Palau and private hatcheries in Taiwan) were prohibitively expensive, at

$20-$40/1,000 post-larvae. In order to provide the local prawn operators with a limited supply of post-larvae so that they could continue their operations without interruption, a small, temporary hatchery was established in March 1978 at facilities supplied by the University of Guam Marine Laboratory. The need for a seawater supply and the lack of suitable rearing tanks at the Department necessitated this move.

A flow-through system (Table 2), the hatchery consisted of a 1000-liter tank for mixing and aerating seawater and (potable) freshwater, two 200-liter rectangular tanks for hatching and rearing larvae to day 10 (stage 4), two 1000-liter and three 500-liter circular tanks for larval rearing (10th day to post-larvae), and one 1000-liter circular tank for holding the post-larvae prior to shipment. The flow rate through the tanks was adjusted to achieve a 150% water exchange per day. A 35-liter conical tank was used to hatch *Artemia* cysts.

Table 2. Production Capability Of Temporary Hatchery

Marine Laboratory:	
Type:	Flow through
Total Volume:	4,000 liters
Maximum Production:	60,000/30 days (staggered age groups allow a more continous production)
Estimated Down Time for Repair and Maintenance:	20%
Maximum Annual Production:	576,000 post larvae

On October 23, 1978, the seawater system became inoperative as a result of Super Typhoon Rita. Due to the lack of equipment and supplies necessary to fix the typhoon damage, and because most of the Division's efforts were being directed toward obtaining a permanent prawn hatchery, the decision was made to discontinue the temporary hatchery.

However, even prior to the typhoon, post-larvae production had been hampered by disease out-breaks during the larval stages of culture. Frequent power outages at the hatchery, for as much as four consecutive days, preceded the disease outbreak. Fluctuating environmental factors produced excessive stress conditions among the larvae. With the outages, the seawater system became inoperative and caused salinity fluctuations in the rearing tanks. In addition, aeration was off during those periods, causing increases in ammonia concentrations, and feeding had to be suspended. This illustrates the need for an alternative emergency power system for the proposed hatchery.

A *Leucothrix*-like bacteria as described by Sinderman (1974) was suspected of causing the larval disease. Disease symptoms included a blackening mainly along the base of the pleopods, on the appendages and at the base of the eye stalks. Out-breaks of the disease usually occurred during the later portion of the larval cycle. Once the disease became established within a tank, a mortality rate of approximately 10% of the population occurred daily. After an out-break of disease, the tanks and all hatchery equipment would be disinfected with a chlorine bath.

Various antibiotics were tested for effectiveness against the disease, and for dosage tolerance levels of the larvae. Erythromycin (5 ppm) and acriflavin (0.5 ppm) were tried and found to be lethal to the larvae. Terramycin (7 ppm) was tested and found to be tolerated by the larvae and caused some recession of the disease.

Prior to the disease outbreaks, the survival rate ranged from 30%-85% with an average of 50% from day 10 to post-larvae. This is comparable to other hatchery systems (Fujimura and Okamoto, 1970). Production ranged from 8 post-larvae/liter to 30 post-larvae/liter. Larvae were fed a diet of fresh fish (mainly tuna), steamed chicken eggs, and Artemia. Improvements were made in the diet by adding protein, vitamins, and mineral sources to the steamed eggs. The total post-larvae production amounted to 55,000. A fee of $4.00/1000 post-larvae was charged to the farmers, and the revenues were placed in a revolving fund so that a portion of the operating costs of the hatchery could be paid from the proceeds.

Food Studies

Guppies are being raised for testing as a food source for prawns. The guppies will be used in place of the Gambusia used in Hawaii prawn ponds. Unfortunately, Gambusia will feed on prawn post-larvae, thereby resulting in some loss in the number of post-larvae stocked in ponds. The guppies, being smaller in size, are not likely to feed on the post-larvae; however, this will be tested. A freshwater snail, Melanoides tuberculata, is also being tested to determine its suitability as a natural food for the prawns. Dr. Nelson of the University of Guam's Marine Laboratory has found that Macrobrachium lar will feed on them. Food costs to the prawn farmers could be greatly reduced if these experiments prove successful.

Chlorine Susceptibility

Macrobrachium rosenbergii have also been tested to determine their susceptibility to chlorine concentrations in the water. At a concentration of 1 ppm chlorine they succumbed in approximately 2 hours. Upon examination, the gills showed extensive hyperplasia. This can be used as a characteristic to help determine the cause of prawn mortality in the ponds. In contrast to those killed by chlorine, prawns that succumb to a low O_2 level do not show hyperplasia of the gills.

C. Permanent Hatchery

In order to attain on-island self-sufficiency in post-larval prawn production, a hatchery capable of producing approximately seven million post-larvae per year has been proposed. Since an on-island hatchery is necessary to support an aquaculture industry, a major effort has been directed towards this goal.

The Guam Department of Commerce is continuing its efforts to secure funding for the construction of the hatchery from the Federal Economic

Development Agency. Funds orginally intended for a fumigation plant, and which could have been reappropriated in June 1979 for the construction of a prawn hatchery, were not obtained because negotiations with the U.S. Navy for an ideal site in Apra Harbor at Sasa Bay remained unsettled. A report prepared by Aquatic Farms Inc. of Hawaii (1978) evaluated and summarized the economic aspects of developing a prawn industry on Guam. This economic study, funded through the Government of Guam, Department of Commerce, will be helpful in securing funding from the Federal EDA for the proposed prawn hatchery. A tentative time schedule calls for construction on the hatchery to start around February 1980, and for it to be in operation about a year later. From here on the Department of Commerce will spearhead all efforts and preparations for the construction and operation of the permanent hatchery. In the interim, the Department of Commerce is subsidizing the purchase of 200,000 post-larvae from Aquatic Farms Inc. so that the prawn farms will not be affected too adversely by the delay in building the hatchery.

FRESHWATER EELS

Guam presently has one entrepreneur engaged in freshwater eel culture. The eels are cultured in concrete-walled ponds with a total area of five (5) hectares. The eel farm reports a monthly harvest of 2.0 metric tons of eels. The majority of the product is shipped to Japan for sale at $10 to $40/kg; however, larger eels are sold locally at $5.50/lb. ($12.10/kg).

Elvers of _Anguilla japonica_ have been obtained mainly through suppliers in Hong Kong, who in turn obtain the elvers from mainland China. The majority of the elvers are grown to market size on Guam; however, some of them are transshipped to Taiwan for a rapid return on the initial capital investment. The importation of products to Taiwan from mainland China is illegal, but after holding elvers on Guam for a short growing period (approximately one month), they have been exported as a product of Guam. The price received for elvers in Taiwan this year ($430/kg) is approximately one third the price in 1978.

At one time the ponds were stocked with approximately 40,000 elvers of _A. rostrata_ imported from South Carolina. The difficulty in obtaining a sufficient supply of _A. japonica_ elvers (at $1,000/kg) necessitated the substitution. However, _A. rostrata_ grow at a substantially slower rate than _A. japonica_, and they are also more susceptible to disease. The upper temperature tolerated by _A. rostrata_ is less than that for _A. japonica_, and they are often thermally stressed on Guam. In addition, the market acceptance of _A. rostrata_ in Japan is not very good due to the toughness of the skin and overall shortness of the body, which makes them less suitable for Kabayaki (barbequed eel) than _A. japonica_.

All the ponds are in operation, except for two ponds that have structural damage. One pond is being used to culture the red hybrid tilapia in brackish water because the freshwater supply has been inadequate during the past dry season. Water quality in all the ponds has been marginal at times. An attempt was made to reuse the water by cycling it through a swimming pool filter. This proved to be impractical, however, since the filter would frequently clog and require back flushing.

Packing process for shipping live ee
to Japan:

UPPER LEFT: placing the eels in pl
bags once they have he
without food in specia
holding tanks (backgro
and iced down to lower
metabolic rate.

ABOVE: addition of oxygen to bagge

LEFT: final packing in cardboard b
that are sealed and containe
at the airport.

SOFT-SHELL TURTLES

The soft-shelled turtle (Trionyx sinensis) is a high-priced item that is considered a delicacy in Taiwan and Japan. The culture of this animal on Guam was initiated by a private entrepreneur, with facilities that include three concrete tanks (20 x 7 x 0.7 meters), an egg incubation house, and a well. Chinese Carp (Aristichthys nobilis, Hypophthalmichthys molitrix, Ctenopharyngodon idellus) and tilapia serve as secondary species in the culture system.

The original stock of turtles came from Taiwan. The stocking density varies according to the size of the turtles, and size segregation is necessary to prevent cannibalism. The turtles mature in 9-10 months on Guam and have a clutch of 10 to 15 eggs. The incubation time ranges from 40 to 50 days at 30°C.

The growth rate of the turtles on Guam is substantially faster than those cultured in Taiwan (Chen, 1976). Feed consists of trash fish, which yields a conversion ratio of 10:1. Turtles reach market size in 8-10 months. Areas of high oriental population are expected to be the most favorable for market development. An export market to Hawaii has been established, and exporting to Hawaii continues on a limited basis. Local marketing of the turtles has been mainly to restaurants; they are always marketed alive.

Due to the expense in feeding and the difficulties in marketing small quantities off-island, however, the turtle culture is being phased out. The facilities would have to be greatly increased to supply the quantities required to compete in foreign markets (Taiwan, Japan), or to cover shipping costs to markets in the States (Hawaii, Mainland U.S.). The main emphasis currently is on the production of the red hybrid tilapia, and on the short-term culture of eels for shipment to Taiwan. The Turtle Farm has already expanded its facilities for the culture of the red hybrid tilapia with the construction of three concrete ponds (28 x 30 x 4 feet).

TILAPIA

A. Monosex Tilapia

Monosex experimentation with sexually indeterminate tilapia fry using the hormone methyltestosterone in their feed for two weeks (Table 3) was initiated in April 1977. After one year of growth in a tank at the Department of Agriculture, these tilapia were sexed and found to have a 93% occurrence of males. During the year some breeding did occur in the tank; however, the reduction in the percentage of females greatly decreased reproduction and the resulting problems of overpopulation and stunted growth. These results are similar to those obtained with methyltestosterone by the staff of the Freshwater Aquaculture Center, Nueva Ecija, Philippines (FAO 1975, 1976).

Table 3. Diets Fed To Sexually Indeterminate Tilapia Fry

Diet 1:	Flour	333g	16.3%
	Yeast	256g	12.6%
	Turkey Starter (Commercial feed pellet 28% protein)	400g	19.6%
	Agar	50g	2.5%
	Methyltestosterone	0.08g	0.004%
	Water	1,000g	49.0%
Diet 2:	Animal Gelatin	300g	9.1%
	Fish Meal	360g	10.9%
	Turkey Starter (Commercial feed pellet 28% protein)	750g	22.7%
	Yeast	300g	9.1%
	Water	1,590g	48.2%
	Methyltestosterone	0.2g	0.006%

The experimental culture of monosex populations of tilapia (Sarotheradon mossambicus) obtained by the use of methyltestosterone in the diet was continued in October, 1977, with the cooperation of the U.S. Navy Fuel Depot Station. A sludge pond (36.0 x 27.0 x 1.7 meters) that had formerly been used to separate fuel oil from water was cleaned and renovated to meet the requirements for fish culture, and made available to Aquatic and Wildlife Resources. The pond was enriched periodically with an inorganic fertilizer (NPK 15:15:15) in order to enhance primary production. A total of only 79 kilograms of fertilizer was used. No other nutrient or food was provided for the fish. After 10 months the pond was drained and the fish were weighed and counted.

Prior to stocking, the tilapia fry were treated with methyltestosterone at a level of 0.006% in the feed in order to increase the percentage of males. The actual percentage of males obtained was 83.5%, less than the expected 90.+%. The culture of a monosex population of tilapia has the advantages of eliminating unwanted breeding within the pond, preventing subsequent over-crowding and stunted growth, and allowing a more manageable culture operation. In addition, the more rapid growth of males as compared to females is advantageous.

Secondary species of fish stocked in the pond were: silver carp (Hypophthalmichthys molitrix), bighead carp (Aristichthys nobilis), and grass carp (Ctenopharyngodon idellus). The net fish production in the pond for 10 months from October 17, 1977 to August 22, 1978 was 108.8 kg, or 1,265 kg/ha (Table 4). While the level of production was not extremely high, it was comparable to levels using similar methods and species in other areas; for example, 800 to 2,000 kg/ha reported from Israel. The low level of production may be attributed in part to inadequate fertilizing on a regular basis.

Table 4. Fish Production for 10 Months in the Navy Fuel Depot Pond

SPECIES	STOCKED NO.	STOCKED MEAN WEIGHT (GM)	HARVESTED NO.	HARVESTED MEAN WEIGHT (GM)	TOTAL WEIGHT (KG)	% SURVIVAL
Sarotheradon	127	0.7	96	284.8	27.36	76
Hypophthalmichthys molitrix	250	0.6	174	305.0	53.07	70
Aristichthys nobilis	50	0.6	24	272.2	6.53	48
Ctenopharyngodon idellus	13	2.8	10	465.0	4.65	77
Undersized Tilapia					17.21	
Total Production					108.82	

The original tilapia exhibited good growth over the 10 month period. They reach sexual muturity in only four months and, with the undesired high percentage of females in the pond, considerable breeding and reproduction did occur. A total of 17.21 kilograms of undersized (F-1) tilapia were retrieved when the pond was drained.

B. Hybrid Tilapia

A red-orange hybrid tilapia resulting from the cross between *Sarotheradon mossambicus* and S. *niloticus* was introduced to Guam from Taiwan in 1973 and 1977. This hybrid is now under commercial culture. The first marketing of the hybrid from the Turtle Farm occurred in August 1978, and consumer acceptance was rated very good. Approximately 80 lbs. were marketed live at the Farmer's Cooperative for $1.60/lb.

Because the appearance of the hybrid is similar to that of a saltwater snapper (Lutjanidae), the hybrids were marketed under the name of "Cherry Snapper". This was done to avoid the local prejudice against tilapia as a food fish. (Locally, the term "tilapia" refers to S. *mossambicus* which is considered an undersirable fish by most residents.) This prejudice was evident during the initial marketing; when tilapia with a normal coloration were marketed under the name "tilapia", they were usually shunned by the Guamanian and Stateside customers; however, the Filipino customers preferred them to the unfamiliar reddish-orange hybrid. Currently, tilapia are sold to restaurants for sashimi at the price of $1.60/lb. Filipino construction workers, however, continue to be the major customers, buying the tilapia directly from the fish farm for $1.25/lb.

The tilapia are normally fed a diet consisting of a commercial poultry feed pellet bound together with powdered commercial eel food. The use of the pellets directly was found to be too wasteful since a large portion of them fell to the bottom of the pond and were not eaten. A feed pellet designed specifically for tilapia has been bought from a company in Taiwan, and it is hoped it will prove to be more economical and effective in the future.

PANGASIUS CATFISH

Several species of the genus *Pangasius*, riverine catfish roughly similar to channel catfish in the U.S., are highly favored food fish in S.E. Asia where they are commonly cultured in ponds and cages. In November 1975 the Department received a stock of fingerling *Pangasius sutchi* from the Thailand Department of Fisheries, through the Regional FAO office, to be used in establishing their culture on Guam. They had grown to a mean length of approximately 50.8 cm by June 30, 1979.

Artificial propagation experiments will be performed on the pangasius catfish once sexual maturity is reached. Eventually, when the fry become available, they will be supplied to the various fish farmers. A total of 32 *Pangasius sutchi* has been stocked in the Navy Pond (10 fish on June 22, 1979) and at Pedro's Farm (17 fish on June 28 and 5 on July 9, 1979) in order to partially alleviate the crowded conditions in the concrete holding tank at the Department. Hopefully the fish will reach sexual maturity in the more natural conditions of the ponds. In addition, splitting the stock among alternate sites will help ensure that the total *P. sutchi* stock on Guam will not be wiped out by some unforeseen disaster at one site.

Earlier in the year, the catfish in the Department's holding tank were treated for an external parasite with copper sulfate (1 ppm). A prophylactic treatment of oxytetracycline (25 mg/ 1 lb. fish) was also administered, since under the present crowded conditions pathogens can spread rapidly throughout the tank.

FISH DISEASE TRAINING

From September, 1978 to March, 1979, the aquaculturist in the Division was on leave to attend a training course in fish diseases at the National Fisheries Center - Leetown, Kearneysville, West Virginia. For six months he was trained in the detection, identification, prevention, and treatment of diseases that plague intensive culture systems. He has since transferred to another Government of Guam agency, and a Fisheries Biologist II was hired on September 24, 1979 from the mainland U.S. as a stateside-contract hire to fill the open position.

DISCUSSION AND RECOMMENDATIONS

Efforts to firmly establish an aquaculture industry on Guam are just now beginning to prove fruitful. The Guam Department of Commerce has requested funding from the Federal EDA for construction of a hatchery, and approval is expected within 2-3 months. The success of the developing aquaculture industry hinges on the construction of a hatchery on Guam to supply *Macrobrachium rosenbergii* post-larvae, and fingerlings of a variety of freshwater fish. The hatchery is necessary if the island is to become self-sufficient in aquaculture.

The Department of Agriculture will continue to provide extension services to the farmers as a major part of the Commercial Fisheries program. These services will include advising and assisting farmers concerning pond site selection, construction, maintenance, stocking rates, water quality testing and control, feeding regimes, harvesting methods, and general pond management. Prospective aquaculturists also will be advised concerning the preliminary requirements prior to entering the field. Cooperation will be sought from the farmers to supply information and to follow prescribed recommendations. Through such a program, information will be gathered to increase production, and the farmers will become sufficiently experienced in the grow-out phase of prawn and fish culture so that they can become essentially self-sufficient.

Attempts at selective breeding of the red-orange hybrid tilapia will continue in the hope of obtaining a true-breeding stock of the hybrid which exhibits a predominantly red-orange coloration. The original cross produced F-1 progeny, of which 25% exhibited the red-orange coloration, while the present generation produces an average of 65% red-orange progeny. Efforts will also be made to improve the red hybrid strain in the hope of eliminating altogether any black coloration normally present in non-hybrids.

When the stock of Pangasius sutchi held at the Department reaches sexual maturity, artificial propagation experiments will be performed. If successful, fry will be supplied to the pond culturists for inclusion in the general polyculture system.

The Department will continue to lend its support toward furthering the development of a diverse and productive aquaculture industry on Guam. Our climate is conducive to a rapid growth rate in many species. Aquaculture has the potential to supply enough fish to meet a substantial portion of Guam's demand for fishery products. In addition to supplying the on-island market, aquaculture is an industry that can produce an export product. Together, these features give aquaculture an important potential role in Guam's economy.

Presently the Department of Agriculture facilities for holding fish stocks consist of four concrete tanks (one 6' x 40' x 3', three 6' x 10' x 3'), and one aluminum tank (7' x 8' x 3'). Each tank has a valved water supply that is gravity fed through a PVC pipe system. Potable water is aerated and stored in a multichambered water tower that allows for the oxidation of chlorine in the water. All tanks are equipped with a drain that allows complete drainage. Plans are being made to expand our facilities. Implementation of these plans appears promising, as the long-awaited tanks which had been ordered from off-island recently arrived.

Report prepared by Evangeline T. Charfauros and Henry G. Tucker.

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Section V

Guam Wildlife Investigations
Project FW-2R-16
(Federal Aid in Wildlife Restoration Act)

Job Progress Report
Research Project Segment

STATE: Territory of Guam

PROJECT TITLE: Guam Fish and Wildlife Investigations

PROJECT NO.: FW-2R-16

JOB TITLE: Study of the Guam Deer

JOB NO.: W-2

Period Covered: July 1, 1978 to September 30, 1979

SUMMARY:

New hunting regulations went into effect this fiscal year season, limiting deer hunting to antlered deer. Hunting license sales increased 21.3%, and the effort required to take one deer increased almost threefold. The estimated legal hunter take was 59 deer. Hunter logs at the Naval Communications Area Master Station (NCS) and Northwest Field (NWF) revealed that the hunting effort in these two areas accounted for 27.2% of the estimated island-wide legal deer hunting effort, but only 13.6% of the estimated legal deer take. Spotlight count means for Anderson Air Force Base and Naval Magazine deer counts decreased slightly from similar data for the previous two fiscal years. Counts conducted at NCS and NWF suggest that either deer are very scarce on these two facilities or that excessive illegal hunting with spotlights at night has biased the technique.

BACKGROUND:

The Guam deer is present in huntable numbers in several localities and therefore has an economic value in terms of recreation, as a utilizable food resource, and as an ecological component of forest communities. Human population pressures are, however, increasing due to a rapidly expanding population and the desire for economic growth and development. Coincident increases in hunting and other forms of recreation that affect wildlife have been predicted and estimated (Johnsrud et al 1966, Souder 1979). The problem is to manage local populations of deer on a sustained yield basis so that this recreation, food and wildlife resource will continue to be available in the future.

The Guam deer has been under investigation by the Division of Aquatic and Wildlife Resources since 1961. The distribution has been mapped and the population trends as well as herd compositions have been determined by conducting night spotlight counts. In addition, statistics on deer hunting have been compiled since 1968 through hunter reporting procedures (AWR 1969-1978). These procedures made it possible to estimate the legal deer kill and the amount of legal hunter effort expended each deer season.

Researchers of Guam deer biology in the 1960's have collected the following information: a list of food plants, a preliminary table for aging Guam deer by tooth eruption and wear, morphological measurements, some parasites, the relative importance (percentages) of a number of known mortality factors, and a life table of the Andersen Air Force Base herd. All available data collected prior to fiscal year 1979 has been analyzed and synthesized in the form of a Final Report (Wheeler, 1979a).

OBJECTIVES:

I. To determine the trend of relative numbers of deer in several areas by conducting night spotlight counts.

II. To attempt to establish some other index of deer abundance or habitat use that may be used in areas where spotlight counts are not practical or reliable.

III. To investigate deer damage complaints and take action or make recommendations to alleviate such damage.

IV. To estimate the level of illegal hunting relative to previous years.

V. To make management recommendations compatible with a sustained yield of Guam deer.

PROCEDURES:

I. Conduct monthly night spotlight counts at Anderson Air Force Base (AAFB), the Naval Magazine (Nav Mag), and other areas that encompass suitable deer habitat. Statistically analyze the monthly count data to test for significant changes from previous years.

II. Compile hunter kill data from hunter report cards and hunter questionaire forms.

III. Acquire information on illegal deer hunting from the Enforcement Section.

IV. Acquire and analyze hunter logs from NCS and NWF.

V. Complete a final report incorporating information on all aspects of deer biology collected up to the end of fiscal year 1978.

VI. Investigate additional sources of funding for the Enforcement Section, such as increased license fees and proposals for increased funding.

VII. Investigate the feasibility of using deer pellet groups as an index of abundance or habitat use.

FINDINGS:

Deer Hunting Statistics

Hunting license sales increased 21.3% from the previous fiscal year to a total of 313 licensed hunters. This increase reverses the trend of decreased license sales for two consecutive years (FY 1977 and FY 1978). This increase has occurred in spite of discontinuing special deer hunts and establishing more stringent regulations for hunting deer (i.e. only antlered deer may now be taken).

Thirty-two hunters returned their report cards (10.2% return), and of these 21 indicated that they had hunted deer (Table 1). Six deer were reported taken from the following areas: NCS (2), NWF (1), Yigo (1), Anao (1), and Tank Farm (1). The reported weight of these hunter kills ranged from a 36.4 kg spike buck to a 227.3 kg(?) three-point buck, with a mean reported weight of 97.3 kg (Table 2). The effort (hunter days) required to take one deer increased by almost a factor of three, from 14.9 hunter days in the 1977 season to 42.7 hunter days in the 1978 season. The primary cause for this increase is most likely the change from either-sex to antlered-only deer hunting. Slight decreases in deer abundance (see below) may also be a contributing factor.

Hunter Check Station Data

Hunter logs were kept throughout the deer and pig season at two hunter check stations: NCS security desk and NWF entrance station. Hunters were required to sign in and out and to report any game taken. Hunter effort and kill data were obtained by compiling data from the logs of these two areas (Table 3). On the basis of a post-season survey (see pig study Progress Report) approximately 86.2% of the hunter effort at these two installations may be considered as directed towards deer. The time expended by hunters at NCS and NWF accounted for about 27.2% of the estimated island-wide legal deer hunting effort, but only 13.6% of the total estimated hunter take for deer.

Table 1. Island-wide deer hunting statistics.

a. License sales:	313
b. No. hunter reports returned:	32
c. Percent returned:	10.2%
d. No. reporting hunters who hunted deer:	21
e. Percent of reporting hunter who hunted deer:	65.6%
f. No. deer report cards returned:	21
g. No. deer taken by 21 hunters:	6
h. Hunter success ((gx100)/d):	28.6%
i. Estimated total number of legal deer hunters (a/e):	205
j. Estimated total legal deer take (hxi):	59
k. No. of 8 hr. hunter days expended by 21 reporting deer hunters:	258
l. Average no. days each hunter spent:	12.3%
m. Estimated total no. deer hunter days (ixl):	2521.5
n. No. hunter days per deer taken (K/g):	42.7

Table 2. Location, weights and antler development of reported hunter deer kills.

Location	No. Taken	Weight (Kg)	Antler Development
NCS	2	45.5,36.4	spike, spike
NWF	1	81.8	3-point
Yigo	1	95.5	4-point
Anao	1	not reported	3-point
Tank Farm	1	227.3	3-point

Table 3. Hunter effort and take at Northwest Field and Naval Communications Area Master Station.

	HUNTER EFFORT (HRS.)				HUNTER TAKE (No. deer)		
MONTH	NCS BOW	NCS GUN	NWF BOW	NWF GUN	NCS BOW	NCS GUN	NWF BOW or GUN
OCT	46.1	1177.6	171	1075	0	1	3
NOV	24.5	930.6	69	901	0	1	0
DEC	16.8	996.7	21	936	0	2	1
TOTAL:	87.4	3104.9	261	2912	0	4	4

Spotlight Count Trends

Monthly spotlight count data at Andersen Air Force Base (AAFB) (Table 4) and Nav Mag (Table 5) were statistically analyzed and compared to similar data from fiscal years 1977 and 1978 using the Mann-Whitney U-test. The count data from AAFB are not significantly different (at $P<.05$) from fiscal year 1978, however, a significant decrease ($P<.01$) in the counts was found in comparison to fiscal year 1977 (Table 6). The mean number of deer per count declined slightly and the maximum count was relatively low.

The Nav Mag deer counts are not significantly different ($P<.05$) from the preceding two fiscal years, however, the mean number per count has decreased slightly (Table 6).

Spotlight counts were also conducted at NWF and NCS this fiscal year, however, these data were reported elsewhere (Wheeler 1979a) and will not be repeated here. Additionally, two spotlight counts were conducted on the Federal Aviation Administration (FAA) property, with a total distance of 4.3 miles traveled. Only one unclassed deer was seen on these counts. It is possible that illegal hunting with spotlights at night has given a negative bias to the spotlight count technique at NCS, NWF and FAA. Hence, there is a need for developing some other method of estimating deer abundance in these areas.

Table 4. U.S. Andersen Air Force Base Deer Herd Composition Counts, FY 1979.

	1978						1979						Total	Ave. No./ Count	Standard Deviation
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June			
Spike	1	0	0	0	0	0	2	2	1	5	0	1	12	2.6	± 1.09
2 pt.	1	0	0	1	0	1	1	2	0	0	1	0	6		
3 pt.	0	0	1	0	0	1	0	3	3	2	1	0	11		
4 pt.	0	0	0	0	0	0	0	0	0	0	0	0	0		
Unclassed	0	0	0	0	0	0	0	0	0	0	0	0			
Doe	16	18	25	16	9	16	12	14	17	21	19	21	204	17.0	± 1.31
Yearling	3	6	3	0	2	3	1	0	3	3	0	1	25	2.1	± 0.54
Fawn	0	1	0	0	0	0	0	0	0	6	2	4	13	1.1	± 0.54
Unclassed	15	13	21	6	5	15	12	11	13	7	13	13	144	12.0	± 1.31
Total	37	38	50	23	16	36	28	32	37	44	37	40	418	34.8	± 2.75
Miles Traveled	4.8	4.7	4.7	4.4	4.3	4.5	4.2	4.3	4.6	4.7	4.6	4.8	54.6	4.6	
Deer/10 mile	77.1	80.8	106.4	52.3	37.2	80.0	66.7	74.4	80.4	93.6	80.4	83.3	912.6	76.0	± 8.18

Table 5. U.S. Naval Magazine Deer Herd Composition Counts, 1979

		1978						1979								
		July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total	Ave. No./ Count	Standard Deviation
Bucks	Spike	0	0	0	2	0	1	0	2	1	3	1	1	11	3.4	± 0.54
	2 pt.	0	0	0	1	0	0	0	0	1	1	1	0	4		
	3 pt.	2	1	0	0	1	0	0	0	0	1	3	0	8		
	4 pt.	0	0	1	0	0	0	0	0	0	0	0	0	1		
	Unclassed	0	0	3	1	3	1	3	2	1	1	2	0	17		
Doe		11	6	9	11	11	4	11	20	12	26	5	13	139	1.6	± 1.85
Yearling		1	1	3	2	1	1	2	1	0	11	1	1	25	2.1	± 0.87
Fawn		1	0	2	1	1	0	4	5	4	5	1	1	25	2.1	± 0.54
Unclassed		10	0	7	8	15	7	3	10	12	13	12	7	104	8.7	± 1.31
Total		25	8	25	6	32	14	23	40	31	61	25	23	333	27.8	± 4.04
Miles		13.4	11.7	13.3	13.2	12.0	12.2	12.0	12.0	11.3	13.4	13.4	14.5	152.4	12.7	
Deer /10 mile		18.7	6.8	18.8	19.7	26.7	11.5	19.2	33.3	27.4	45.6	18.7	15.9	262.3	1.9	± 3.05

Table 6. Three year summary of deer spotlight count maximums and means, and results of the Mann-Whitney U-test (two-tailed) for significant difference between 1979 and the preceding two fiscal years.

	AAFB			NAVMAG		
Fiscal Year	1977	1978	1979	1977	1978	1979
No. Counts	12	12	12	11	12	12
MAX Count	58	86	50	61	44	61
MEAN/Count	47.4	44.1	34.8	33.8	28.1	27.
Significant Difference	P<.01	NS	X	NS	NS	X

STOP
GAME CHECK
STATION

Wildlife biologist manning a hunter check station.

Sampling Intensity and Sensitivity

Coefficients of variation (CV) were calculated for each of the last five years of spotlight counts at AAFB and NavMag. These data were then averaged to yield a mean statistic for each area with the following results: for AAFB $\overline{CV} = 26.2\%$ and for NavMag $\overline{CV} = 33.5\%$. The following formula (Sokal and Rohlf 1969) was solved for δ, the smallest true difference that it is possible to detect:

$$n \geq 2\left(\frac{\sigma}{\delta}\right)^2 \{t_{\alpha\{\nu\}}+t_{2(1-P)\{\nu\}}\}^2$$

where n = number of replications, σ = the true standard deviation, ν = degrees of freedom, α= significance level (chosen to be 0.05), and P = the desired probability that a difference will be found to be significant (chosen to be 80%). The ratio of C.V. to the percentage of the mean of the smallest true difference that it is possible to detect was substituted for σ/δ , yielding:

$$\text{Percent change in mean that can be detected (PCM)} = \overline{CV}\sqrt{\frac{2\{t_{.05\{\nu\}}+t_{2(.2)\{\nu\}}\}^2}{n}}$$

The equation was solved using sampling intensities of n = 12, 24 and 48 to determine what level of change in the counts may be detected at different sampling intensities (Table 7).

Table 7. Spotlight count sampling intensity and percentage of change in the count means (PCM) that may be detected.

Sampling Intensity (N)	PCM AAFB	PCM NAVMAG
12	32.9	42.1
24	22.1	28.3
48	15.5	19.8

At the present frequency of spotlight counts (once per month) using a significance level of .05, there must be a change of at least 32.9% in the count mean of AAFB for such a change to be detected as significant. Increasing the sampling intensity to biweekly counts would decrease the amount of change that could be significantly detected to 22.1%. Similarly, for NavMag at the current level of sampling the count mean must change by at least 42.1% for such a change to be detected as significant, and doubling the number of counts per year would decrease the percentage of change that can be detected to 28.3%. Consideration should be given to increasing the frequency of spotlight counts to give added precision to these trend estimators. For NavMag almost half of the population would have to be taken in one year for the change to be noted as significant.

Table 8. July - September 1979 deer spotlight counts at AAFB and NAVMAG

		AAFB 1979				NAVMAG 1979			
		July	Aug.	Sept.	Mean	July	Aug.	Sept.	Mean
Bucks	Spike		3	3	2.0				0
	2 pt.		3	3	2.0				0
	3 pt.	1	5	5	3.7	3		1	1.3
	4 pt.				0				0
	Unk.		1		.3		2		0.7
Doe		9	29	26	21.3	5	1	15	7.0
Yearling		2	5	6	4.3	1			.3
Fawn		1	3	6	3.3		1	5	2.0
Unident.		8	21	21	16.7	6	7	2	5.0
Total		21	70	70	53.7	15	11	23	16.3
Miles Traveled		4.7	4.7	4.7	14.1	11.1	11.1	11.0	12.0

July-September Counts

Because of a change in the starting time of the fiscal year from July 1 to October 1, this reporting period also includes spotlight counts conducted at AAFB and NavMag from July to September 1979 (Table 8). These data were collected subsequent to the preceding analyses and show slightly higher numbers of deer at AAFB and fewer deer at NavMag. It is not possible to show a trend from just three counts, but two successive counts of 70 deer at AAFB may be an early indication of a reversal in the downward trend of deer numbers in this area. For NavMag the opposite situation was noted; the most recent counts were well below average.

Deer Damage Complaints

A complaint was received from personnel at AAFB following a deer-aircraft collision, and consequently two spotlight counts were conducted in the area of the west flight line, along 32nd street, and behind the Weapons Storage Area (the latter two areas are included in the regular monthly spotlight count and were surveyed the same night for comparison). Along the flight line only two deer were seen on the first count and no deer were seen on the second. In the other areas, 16 and 39 deer were seen. It was concluded that deer were not abundant in the flight line area and it was recommended to AAFB personnel that two gates to the flight line be closed at night to help prevent deer from entering the flight line.

Illegal Hunting (July 1978-June 1979)

The Enforcement Section reported 9 arrests for illegal hunting and 22 incidents of illegal huning in which no arrests were made. The majority of these incidents involve spotlighting deer at night. These arrests and incidents represent a 72% increase over the previous fiscal year.

A proposal was drafted and funding has been secured from the Coastal Zone Management Program (CZM) for the addition of one Conservation Officer and one vehicle to the Enforcement Section. In addition CZM is funding a fulltime position in the Division to be devoted towards conservation education. Hopefully these new positions will help to diminish the illegal hunting problem.

Bibliography

An effort was initiated this report period to develop a bibliography of Sambar deer (*Cervus unicolor*) and Asiatic water buffalo (*Bubalis bubalis*). Coverage will be Biological Abstracts and BioResearch Index 1969-1979. The bibliogrpahy will be completed by the end of fiscal year 1980.

Pellet Group Index

Work was initiated this report period to develop an index of deer use based on the number of new pellet groups observed in a series of 10m square plots. The index is being developed in an unhunted, highly restricted area of AAFB that is monthly surveyed during the spotlight counts. The number of new pellet groups will be related to actual number of deer observed using the area during each spotlight count. After ten data points have been obtained, the variance will be determined and the feasibility of using the index in other areas will be evaluated.

Wild Asiatic Water Buffalo

Data collected on wild Asiatic water buffalo (*Bubalis bubalis*) during deer spotlight counts conducted on NavMag between 1964 and 1978 were collated and analyzed, and a status report on this species was prepared, incorporating recommendations for management and future research on this species. This paper was submitted to Micronesica and is currently under review.

Water buffalo were sighted during all of the deer spotlight counts conducted on NavMag this report period. From July 1978 to June 1979 the mean number observed was 33.0 and the maximum observed in one night was 47. These data further confirm the increasing trend in water buffalo numbers on NavMag (Wheeler 1979b).

RECOMMENDATIONS:

I. Long term recommendations for future research and management of the Guam deer may be found in the Final Report. For the short run, it is a rather tenuous argument to accept spotlight counts as the sole indicator of population trend, particularly for places such as NCS and NWF where poachers commonly employ the technique to illegally take deer. The projections of the demand for outdoor recreation (Johnsrud et al. 1966, Souder 1979) forecast an increasing demand for hunting, however, the opportunities for legal deer hunting on Guam are limited. If the demand not accommodated by legal hunting continues to find an outlet in illegal hunting, the bias inherent in deer spotlight counts will get worse. There is an immediate need to develop some other method of ascertaining deer abundance. It is hoped that the pellet group index will fulfill this need.

II. The frequency of the regular deer spotlight counts at AAFB and NavMag should be increased from monthly to biweekly so that smaller changes in this trend estimator may be detected.

LITERATURE CITED:

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Wheeler, M.E. 1979a. The biology of the Guam deer. Aquatic and Wildlife Resources Division Technical Report No. 3. Government of Guam, Agana Guam. 53 pp.

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Report prepared by: Michael E. Wheeler

Small group of water buffalo on the U. S. Naval Magazine.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT TITLE: Guam Fish and Wildlife Investigations

PROJECT NO.: FW-2R-16

JOB TITLE: Study of the Fruit Bat

JOB NO.: W-4

Period Covered: July 1, 1978 to September 30, 1979

SUMMARY:

The population status of the Marianas fruit bat on Guam, Rota, Tinian and Saipan has been determined. The population on Rota is depressed while populations on Guam, Tinian and Saipan are severely depressed. Fruit bat imports to Guam have increased by 79.9% since last fiscal year, and the majority of this increase has been in bats from Palau. Bat imports from the Northern Marianas Commonwealth to Guam increased by approximately 7% since last fiscal year. Over a five-year period, bat imports from Rota, Tinian and Yap have peaked and are now declining, probably as a result of over-utilization. Bat imports from Palau continue to rise and are now approaching an annual rate of 20,000 bats. The fruit bat bibliography is nearing completion. Investigation of four caves for the insectivorous bat Emballonura semicaudata yielded negative results. Illegal hunting has increased, however, additional funding for the Enforcement Section has been secured. Funding has also been obtained to launch a wildlife conservation education program, part of which will be directed towards fruit bats.

BACKGROUND:

The Marianas fruit bat (Pteropus mariannus mariannus) is endemic to the Mariana Islands and is now considered endangered on Guam. This species has been proposed for endangered status under the Endangered Species Act of 1973 (Appendix). The Marianas fruit bat, considered a delicacy among the indigenous people, has been under investigation by the Aquatic and Wildlife Resources Division (AWR) of Guam since 1962 (A.W.R. 1964-1978). These investigations documented a steady decline in a population index throughout the 1960's (Perez 1972, 1973). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in the prime habitat on Guam which once supported colonies numbering in the hundreds (Wheeler and Aguon 1978, Wheeler 1979a). Reasons for the decline include: increased human population pressures resulting in over-hunting and permanent habitat loss, commercial exploitation of this food species, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislatures in passing protective legislation (Wheeler 1979a).

The Marianas fruit bat is culturally important to the indigenous people of Guam, and some concerned individuals have expressed a great interest in preserving this species. The Marianas fruit bat is also an integral component of the limestone forest ecosystem and is undoubtedly an agent for dispersal and pollination of a number of deciduous, broad-leaved evergreens. If this fruit bat is allowed to be completely extirpated from Guam or other islands in the Mariana Chain, a diverse and invaluable ecosystem may suffer. Since man is responsible for the diminished numbers of Marianas fruit bats, it is appropriate to channel efforts towards restoring population and preserving this species for future generations of mankind.

OBJECTIVE:

The objective is to develop and implement a recovery program and species management plan for Marianas fruit bats.

PROCEDURES:

I. Conduct a literature search and compile a selected bibliography on the genus Pteropus that will be of use for investigators on Guam and elsewhere in Micronesia.

II. Determine the current status, distribution and natural history of Marianas fruit bats in the Mariana Islands.

III. Review the records of requested and actual number of fruit bat imports on file at the Department of Agriculture and determine for each month how many bats were requested and how many were actually imported from each island. Make management recommendations to the appropriate administrative personnel.

IV. Monitor bat numbers in five areas on Guam. Establish two observation stations in each of the five areas to be surveyed (Figure 1), and twice monthly spend one hour (between sunrise and 4 hr. subsequent to sunrise) at each station observing for bats with binoculars or a spotting scope. For each bat sighted record the following data when applicable: flight elevation and duration (distance and time if possible); roosting tree species and height; roosting height in tree; forage tree species, part of plant eaten (fruit, flower, etc.); height in foraging tree; sex; and behavioral observations.

V. Investigate caves on Guam for the presence of Emballonurid bats.

FINDINGS:

During this fiscal year four papers were prepared for publication: a status and distribution report of the Marianas fruit bat on Guam (Wheeler and Aguon 1978), a review paper of all research conducted on the Marianas fruit bat (Wheeler 1979a), a natural history story on a day in the life of a fruit bat (Wheeler 1979b), and a report on 1979 surveys of fruit bat numbers on Rota, Tinian and Saipan (Wheeler 1979c). Findings prepared for these publications will not be duplicated here.

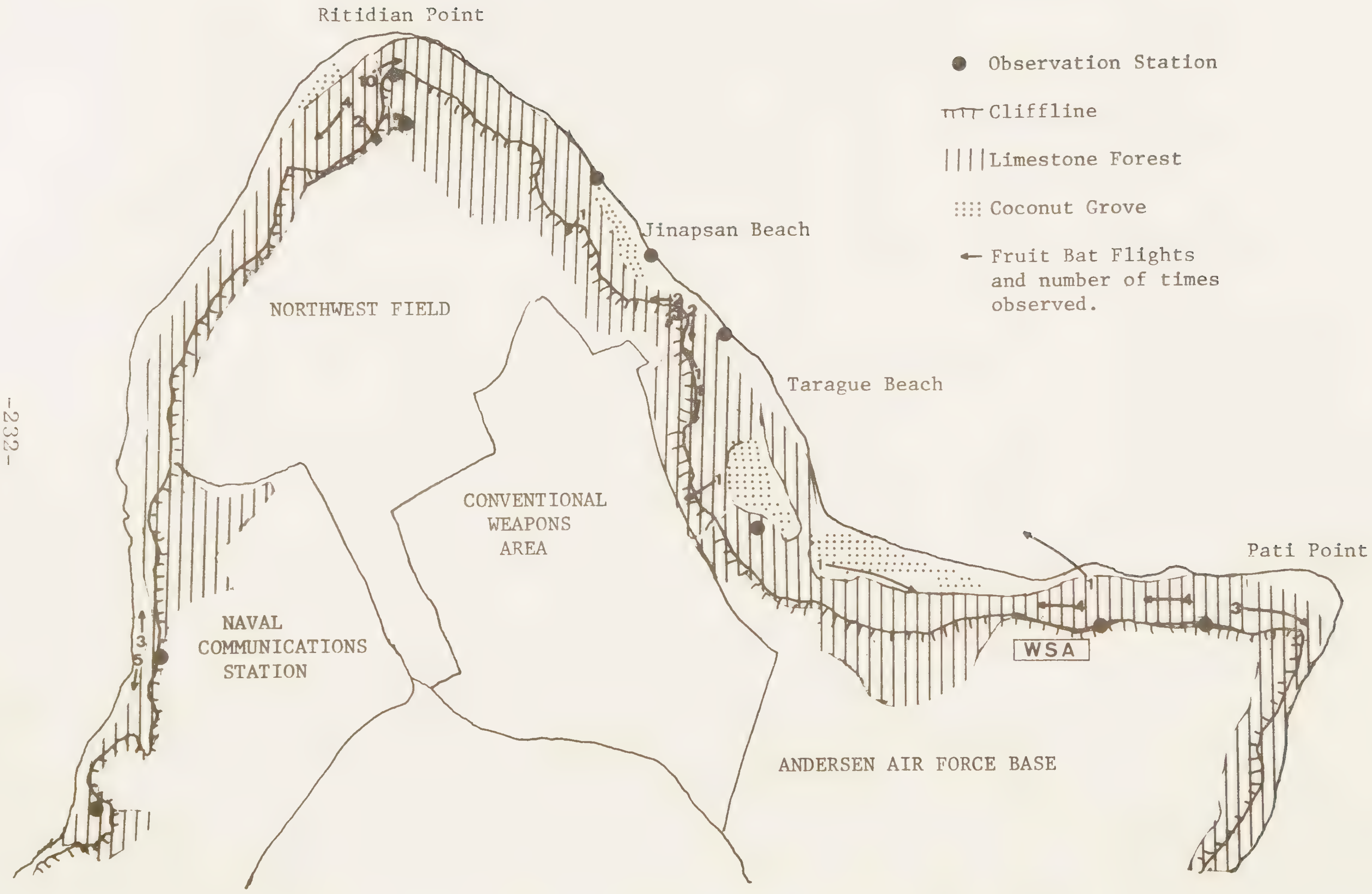

Ritidian Point
Jinapsan Beach
Taraque Beach
Pati Point
NORTHWEST FIELD
CONVENTIONAL WEAPONS AREA
NAVAL COMMUNICATIONS STATION
ANDERSEN AIR FORCE BASE
WSA
● Observation Station
Cliffline
||||Limestone Forest
:::: Coconut Grove
← Fruit Bat Flights and number of times observed.
10
4
2
1
2
2
1
1
1
1
4
4
3
3
5

Figure 1. Fruit bat observation stations and study area.

Bat Population Monitoring Surveys on Guam

One full year of data has been collected and analysed subsequent to the intensive island-wide survey conducted in summer, 1978 (Tables 1 and 2). The number of bats sighted at NCS and Jinapsan Beach remained relatively low throughout the year, however, the number of bats sighted in the Tarague area peaked to a total of nine bats sighted in one day during the first three months of 1979 (Figure 2). More optimistically, a small group of 8-13 bats made use of the Ritidian area February to May 1979, and bat colony sightings and observations were made at Pati Point during three distinct periods: January 1979 (43-46 bats), April-June 1979 (72-112 bats), and August 1979 (35-85 bats). From my experience in observing colonial roosting bats, it seems unlikely that such a colony would have been overlooked in the previous island-wide bat survey due to the amount of flight activity and vocalizations that occur within such a large group of bats. The appearance of this colony is, therefore, probably the result of immigration to the study area and possibly immigration to the island from Rota. The last colony of this size on Guam was sighted in 1973 (Wheeler and Aguon 1978) in precisely the same area. A colony was first observed roosting on the forested limestone terrace behind the northeast corner of the weapons storage area (WSA) of AAFB during the month of January. This colony moved and was not seen February or March. A colony (probably the same one) then appeared in April at a previously identified roosting area at Pati Point (see Wheeler and Aguon p. 15), and remained through the month of June before moving. No colony sightings were made in July, but in August a colony was again sighted at Pati Point. The most recent surveys (September 1979) show that bat numbers are again quite low in the study areas. The colony apparently has some other roosting location on Guam or possibly migrates between Guam and Rota on an infrequent basis.

Fruit Bat Flight Speeds

On four separate occasions the flight speeds of single flying bats were estimated by determining the distance flown on a topographic map and timing the flights with a stopwatch:

Distance Flown(Mi)	Time (Sec)	Speed (MPH)	Elevational Change (ft)	Head wind or Tail wind?
1.0	190	18.9	None	No
.39	40	33.9	-50	No
.39	50	27.3	-50	No
.55	67	29.5	+75	No

The results indicate that *P. mariannus* is a strong flyer, and effectively the entire island is easily within its reach over a period of a day or night. Carpenter (1975) trained *P. poliocephalus*, an Australian species of flying fox that is smaller than *P. mariannus*, to fly in a wind tunnel at air speeds of 11.2-17.9 mph for periods of over four hours. Assuming the Marianas fruit bat is capable of sustained flight for similar periods of

Table 1. Number of bats sighted during twice-monthly two hour surveys in five areas and occasional surveys in three areas on Guam.

	NCS	RITIDIAN	JINAPSAN	TARAGUE	PATI PT.	OROTE Bats/Hrs.	ANAO Bats/Hrs.	FENA Bats/Hrs.
OCT.	0	1	2	1	1			
OCT.	0	4	0	0	1			
NOV.	2	2	1	1	5	0/2 (on land)		
NOV.	1	2	3	0	2		0/1.5	
DEC.	1	1	1	1	5			1/4
DEC.	1	4	1	3	10			
JAN.	4	3	3	3	43			
JAN.	1	5	0	1	46			
FEB.	1	13	1	4	1			
FEB.	2	11	1	9	2			
MAR.	0	12	1	2	0		0/1.5	
MAR.	0	7	2	5	2			
APR.	1	6	0	3	73			
APR.	1	8	1	4	72			
MAY	1	10	1	1	112			
MAY	0	11	0	3	93			
JUNE	0	3	0	1	97			
JUNE	1	2	0	0	108			
JULY	4	2	1	1	5			
JULY	0	2	2	2	0			
AUG.	0	0	0	0	35	0/2 (by boat)	0/1	1/4
AUG.	1	2	1	3	85			
SEP.	0	2	1	3	6			
SEP.	1	1	0	1	3			
Total	23	114	23	50	807	0	0	2
$\bar{X}$	1.0	4.7	1.0	2.1	62.2	0	0	1
RANGE	0-4	0-13	0-3	0-9	0-112			
S.D.	.2	.8	.2	.4	9.7			

Table 2. Quarterly analysis of bat sightings in five limestone forest areas on Guam (October 1978 - September 1979).

	NCS	RITIDIAN	JINAPSAN	TARAGUE	PATI POINT	TIME PERIOD
Hectares	29	98	88	78	103	
Total Bat Sightings	5	14	8	6	24	OCT to DEC
RANGE	0-2	1-4	0-3	0-3	1-10	
$\overline{X}$	.83	2.33	1.33	1.00	4.00	
S.D.[a]	.33	.61	.46	.40	1.55	
M.O.D.[b]	2.76	1.63	1.36	1.54	3.88	
$\overline{X}$ O.D.[c]	1.19	.95	.60	.51	1.55	
Total Bat Sightings	8	52	8	22	94	JAN to MAR
RANGE	0-4	3-13	0-3	1-9	0-46	
$\overline{X}$	1.33	8.67	1.33	3.67	15.67	
S.D.[a]	.67	1.83	.46	1.37	10.00	
M.O.D.[b]	5.71	5.31	1.36	4.61	17.86	
$\overline{X}$ O.D.[c]	1.90	3.54	.60	1.88	6.08	
Total Bat Sightings	4	40	2	12	555	APR to JUN
RANGE	0-1	2-11	0-1	0-4	72-112	
$\overline{X}$	.67	6.67	.33	2.00	92.5	
S.D.[a]	.23	1.64	.23	.72	7.59	
M.O.D.[b]	1.43	4.49	.45	2.05	43.49	
$\overline{X}$ O.D.[c]	.96	2.72	.15	1.03	35.92	
Total Bat Sightings	6	9	5	10	134	JUL to SEP
RANGE	0-4	0-2	0-2	0-3	0-85	
MEAN	1.00	1.50	.83	1.67	22.33	
S.D.[a]	.69	.37	.34	.54	14.87	
M.O.D.[b]	5.71	.82	.91	1.54	33.01	
$\overline{X}$ O.B.[c]	1.43	.61	.38	.86	8.67	

[a] Standard deviation
[b] Maximum observed density (Bats/40 ha)
[c] Mean observed density (Bats/40 ha)

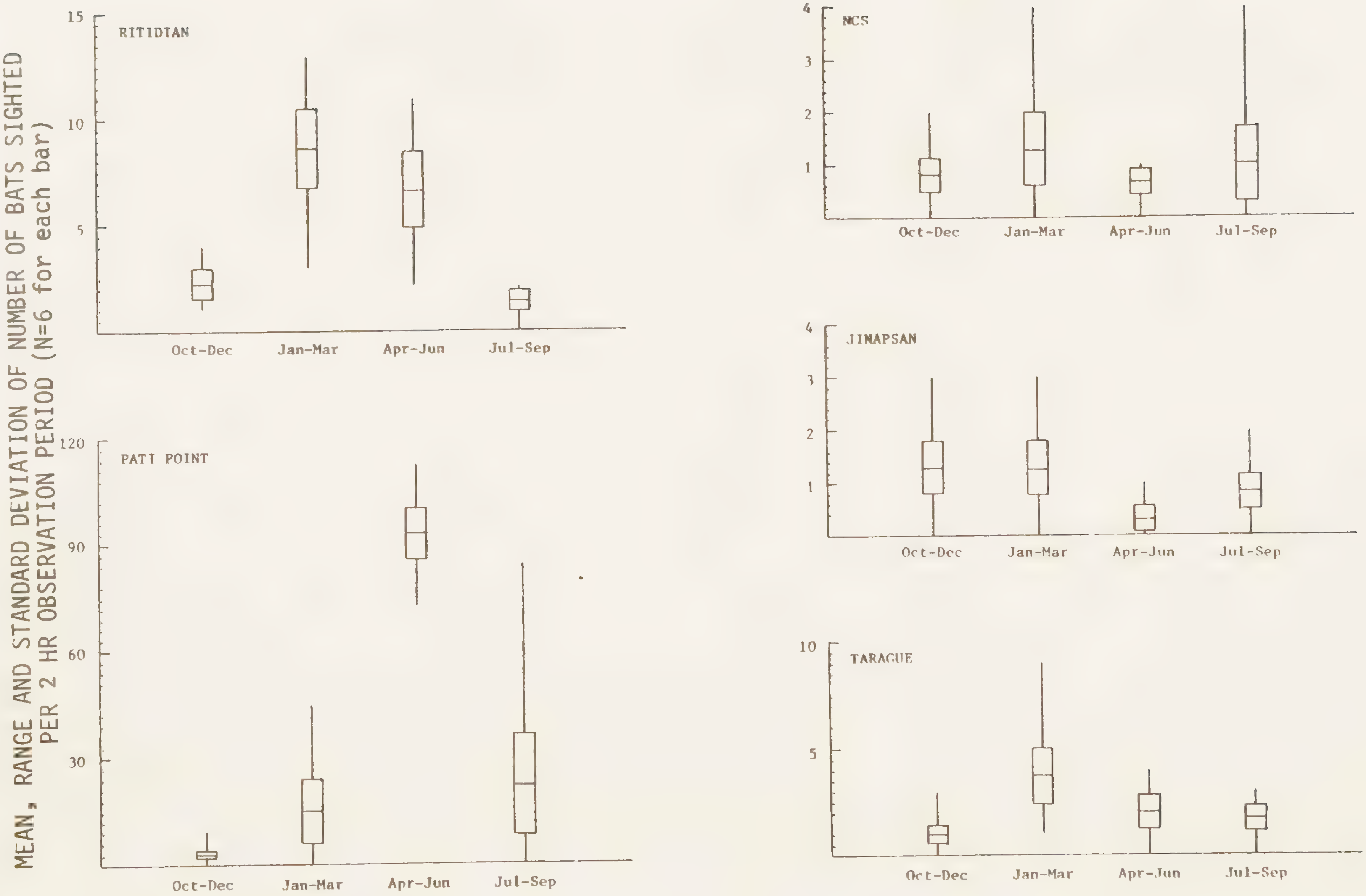


Figure 2. Quarterly trends in bat sightings in five limestone forest areas on Guam.

time, it is physically and physiologically quite possible for these bats to fly between islands in the Marianas chain.

Sex Ratio

With a spotting scope it was possible to sex 31 colonial roosting bats at Pati Point. In addition, 16 non-colonial roosting bats were sexed at Ritidian Point and Pati Point as follows:

	Colonial Roosting Bats		Non-Colonial Roosting Bats	
Time Period	♂	♀	♂	♀
Jan-Mar.	4	7	9	7
June	8	12		

From these preliminary data it appears that there may be a slight preponderance of females within the colony, but approximately an equal sex ratio or a slight preponderance of males outside of the colony.

Color Variation

A small number of Marianas fruit bats have a snowy white mantle instead of the typical buff colored mantle. Some local people are of the belief that only males have this white coloration. Of 46 bats observed during one colonial observation period, three bats had white mantles and of these three one was a female and one was a male. So this color variation does not seem to be a factor of sex, and instead may be related to age or is simply a genetic variation.

Vocalizations

Nelson (1962) distinguished twenty-two calls in Australian fruit bats and Neuweiler (1968) reports that eight different types of calls were distinguished in *Pteropus giganteus*, and calls are used in quite a variety of social contexts. In my observations of colonial roosting Marianas fruit bats, vocalizations could frequently be heard, particularly in the early morning as the bats are coming in to roost for the day and establishing territorial space within the colony. Three types of vocalizations have thus far been distinguished in the Marianas fruit bat, involving agonistic threats, reproductive calls, and a warning or alarm call. One vocalization is a rapid series of sharp "erh"s:

erh - erh - erh - erh - erh - erh

|—— 1 sec ——+—— 1 sec ——|

A second vocalization is slower and more drawn out:

errrrrrrrrrren - errrrrrrrrrren - errrrrrrrrrren

|—— 1 sec ——+—— 1 sec ——|

and is sometimes broken with a noise made during the intake of the breath:

errrren - uh - errrren - uh - errrren

The third vocalization noted was a short, high squack which was emitted as I was approaching the colonial roosting area, and may be a form of alarm call.

This accounting of vocalization is not exaustive and P. mariannus may use many other calls as well. If the colony is relocated, further work may be done to document these calls and to obtain recordings with a parabolic microphone.

Foraging Behavior

Five incidents of fruit bats actually feeding were recorded since September 1978 as follows:

Species	Incidents of Feeding on Flower	Incidents of Feeding on Fruit
Cocos nucifera	1	
Ficus prolixa		2
Herandia mymphaeifolia		1
Dendrocnide latifolia (Fleshy male infloresence)	1	

One fruit bat was observed going from coconut tree to coconut tree (Cocos nucifera) in the Tarague Beach area until it had visited 7 different trees over a period of one hour. It was observed feeding at one tree and may have fed at others, having spent an average of 4.7 minutes at each tree (range .5 to 20 min.). Numerous observations were made of fruit bats flying from Ficus tree to Ficus tree near Pati Point and behind WSA and although only two feeding incidents were actually observed, it is possible that they were feeding quite heavily on Ficus fruits, but the dense canopy made observation difficult. The feeding on Dendrocnide latifolia is of interest, since the female inflorescences are equipped with numerous stinging hairs. The tree being foraged on had only male inflorescences at the time, and these were not equipped with stinging hairs.

Flight Activity

Many of the fruit bat sightings were made of fruit bats in flight. Such flights were classified as either short and local (meaning the bat did not leave the observation area), or long-distance flights in which the bat did leave the observation area. One hundred seventy-one flights were recorded and classified between September 1978 and August 1979 as follows:

Study Area	No. Local Flights	No. Long-distance Flights
NCS	6	8
Ritidian	41	16
Jinapsan	14	7
Tarague	29	4
Pati Point	35	11
Total	125	46

These data do not include intra-colonial flights that are quite common in the early morning as colonial roosting bats establish and maintain individual space. Local flights are almost three times more common than long-distance flights. The origins, flight paths and directions of all long distance flights were mapped (Fig. 1) and show that most of these flights follow the forested limestone terrace below and parallel to the cliffline.

Roosting Trees

Numerous observations were made of fruit bats going to roost on various trees. The tree species, tree height, roosting height and roosting duration were recorded when possible (Tables 3 and 4). Duration was divided into two categories: 20 or more minutes, and less than 20 minutes. During the dry season (January-June) 57.1% of the roosting incidents were of 20 or more minutes duration, however, during the wet season only 35.8% of the roosting incidents were of 20 or more minutes duration. By far the most preferred roosting trees were members of the genus *Ficus*, three species of which are present in the study areas *F. prolixa*, *F. tictoria* and *F. microcarpa*. It was not always possible to differentiate the three at a great distance, observing with a spotting scope, and in such cases the roosting tree was denoted as *Ficus* sp. During the dry season 58.6% of all solitary and small group bat roosting observations were on *Ficus*, and during the wet season this figure decreased to 52.8%. Fig trees, in addition to providing a food resource in the form of fruits, offer a dense canopy for cover and protection, and are probably preferred for these reasons. Numerous other tree species were of lesser importance for roosting, and most of the trees selected for roosting on represent mature, forest-canopy level trees. Some exceptions are *Casaurina* and *Bikkia* growing on the sides of sheer limestone cliffs.

Colonial roosting fruit bats also made extensive use of *Ficus* trees for roosting (Table 5), while *Guettarda*, *Premna*, *Ochrosia* and *Mammea* were of lesser importance as colony roosting trees.

Observations of the Fruit Bat Colony

When the colony was first observed behind WSA, it appeared to be dynamic with individuals leaving and joining throughout the day. The colony occupied an area of less than .5 ha and several additional bats were distributed about in peripheral areas. First sighted January 5, the colony roosted at the same location for three weeks before moving. After the colony had moved, the precentage cover of the different plant species at the colonial roosting site was visually estimated: *Ficus* 35%, *Aglaia* 25%, *Cynometra* 25%, *Ochrosia* 15%, *Cyca* 5%, *Macaranga* 3% and *Mammea* 3%. The substrate was rocky limestone and had a slope of about 45°.

Table 3. Fruit bat roosting trees during the dry season (January - June 1979).

Species	Frequency Of Occurrence	Percent	Tree Height Range(m)	Tree Height Mean(m)	Roosting Height Range(m)	Roosting Height Mean(m)	Incidents of Roosting For more than 20 min. Frequency	Incidents of Roosting For more than 20 min. Percent	Duration Range of Incidents of less than 20' min. (min)	Mean Duration of Incidents of less than 20 min. (min)	Foraging Notes*
Ficus sp.	27	38.6	6.1-12.1	9.9	4.5-10.6	8.7	20	74.1	4.0-9.0	8.2	
Ficus prolixa	13	18.6	6.1-12.1	10.0	6.0-10.6	9.0	8	61.5	0.1-5.0	2.1	A,B
Cocos nucifera	10	14.3	6.1- 7.6	6.8	6.1- 7.6	6.8	4	40.0	0.4-4.3	2.1	A,C
Artocarpus sp.	3	4.3	9.0-10.6	9.6	6.1- 9.1	8.1	1	33.3	4.0-6.0	5.0	C
Hibiscus tiliaceus	3	4.3	6.0- 9.0	7.0	5.1- 7.5	6.0	0	0	-	1.0	B
Casuarina equisetifolia	2	2.9	3.0- 7.6	5.3	3.0- 6.1	4.5	0	0	2.2-4.0	3.1	
Guettarda speciosa	2	2.9	3.0- 9.1	7.6	4.5- 7.6	6.0	1	50.0	-	2.0	
Undetermined	2	2.9	3.0-10.6	6.8	1.5-10.6	6.1	1	50.0	-	-	
Snag	2	2.9	6.1- 9.1	7.6	5.1- 7.6	6.3	2	100	-	-	
Guamia mariannae	1	1.4	-	6.1	-	6.1	0	0	-	5.0	
Ficus microcarpa	1	1.4	-	4.5	-	4.5	0	0	-	4.0	
Permna obtusifolia	1	1.4	-	9.1	-	7.6	1	100	-	-	
Barringtonia asiatica	1	1.4	-	5.2	-	4.5	1	100	-	-	
Morinda citrifolia	1	1.4	-	6.0	-	4.5	1	100	-	-	
Hernandia nymphaeifolia	1	1.4	-	9.1	-	7.5	0	0	-	-	A

* Foraging Notes:
A Foraging observed between September 1978 and September 1979.
B Foraging observed during summer, 1978.
C Historical foraging tree species (Safford 1905, Linsley 1934).

Table 4. **Fruit bat roosting trees during the wet season** (October - December 1978 and July - September 1979).

Species	Frequency Of Occurrence	Percent	Tree Height Range(m)	Tree Height Mean(m)	Roosting Height Range(m)	Roosting Height Mean(m)	Incidents of Roosting For more than 20 min. Frequency	Incidents of Roosting For more than 20 min. Percent	Duration Range of Incidents of less than 20' min. (min)	Mean Duration of Incidents of less than 20 min. (min)	Foraging Notes*
Ficus sp.	18	34.0	9.1-12.1	11.1	3.0-12.1	9.0	9	50.0	1.0- 8.0	3.3	
Ficus prolixa	5	9.4	6.1-12.1	10.3	4.5-12.1	8.8	1	20.0	1.0- 4.0	2.6	A,B
Ficus microcarpa	5	9.4	7.6- 9.1	8.8	6.1- 9.1	7.3	1	20.0	1.3- 5.0	3.0	
Premna obtusifolia	5	9.4	6.1-12.1	9.7	6.1-10.6	8.2	2	40.0	1.0- 2.0	1.3	
Hibiscus tiliaceus	3	5.7	6.1- 7.6	6.8	4.5- 6.1	5.3	0	0	0.2- 3.0	1.2	B
Macaranga thompsonii	3	5.7	9.1- 9.1	9.1	7.6- 7.6	7.6	1	33.3	1.0- 3.0	2.0	
Casuarina equisetifolia	3	5.7	1.5- 6.1	3.5	0.9- 6.1	3.1	1	33.3	0.2-15.0	7.6	
Aglaia mariannensis	2	3.8	6.1- 9.1	7.6	6.1- 7.6	6.8	1	50.0	-	5.0	B
Bleekeria mariannensis	2	3.8	4.5- 6.1	5.3	4.2- 5.4	4.8	2	100	-	-	
Artocarpus sp.	1	1.9	-	9.1	-	-	0	0	-	5.0	C
Cynometra ramiflora	1	1.9	-	9.1	-	7.6	1	100	-	-	C
Ochrosia oppositifolia	1	1.9	-	9.1	-	8.5	0	0	-	4.0	
Pisonia grandis	1	1.9	-	15.1	-	13.6	0	0	-	3.0	
Pandanus fragrans	1	1.9	-	5.1	-	3.6	-	-	-	-	C
Bikkia tetranda	1	1.9	-	1.5	-	1.2	0	0	-	7.3	
Dendrocnide latifolia	1	1.9	-	7.6	-	6.1	-	-	-	-	A

* Foraging Notes:
A Foraging observed between September 1978 and September 1979.
B Foraging observed during summer, 1978.
C Historical foraging tree species (Safford 1905, Linsley 1934).

Table 5. Roosting tree species utilized by a Marianas fruit bat colony.

SPECIES	JAN 26	APR 12	14	16	19	20	23	25	27	30	MAY 1	3	10	30	JUN 4	JUN 18	Mean No. Bats	Relative Percent
	Behind WSA	PATI POINT														Behind WSA		
	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats	No. Bats		
Ochrosia oppositifolia	28				1												1.8	2.1
Mammea odorata	5			1						4	4		4	2	3	2	1.6	1.9
Ficus prolixa	3	73	56	64	79	78	88	76	73	87	62	94	62	87	81	23	67.9	80.4
Premma obtusifolia			12											7		32	3.2	3.8
Guettarda speciosa				18		2	9	10	6	3	5	7	5		4		4.3	5.1
Undetermined					7	1					20	19	20	13	9		5.6	6.6

The number of occurrances of vocalizations and different types of flight activities were recorded during two days of observation of a colony of at least 50 bats roosting behind WSA (June 28-29, 1979) and during three days of observation of a colony of at least 85 bats roosting near Pati Point (August 20-22, 1979) (Table 6). Flight activity and vocalizations occur most frequently early in the morning, and are often related to relocation-displacement behavior during which a bat flies to a branch occupied by one or more other bats, begins fighting and vocalizing and displaces a bat that was previously located on the branch. The displaced bat may repeat the process. Other types of flight activity involved: additional bats going to roost in the colony from some area apart from the colony; bats within the colony leaving to roost in a more isolated location; or bats separate from the colony flying from tree to tree, possibly foraging.

Other types of behavior of colonial roosting bats included sexual activity, self-grooming, grooming another bat, hanging alert or on guard, hanging in a resting posture, or thermoregulating by wing flapping, wing spreading or shade seeking.

Interspecific Associations

A record was maintained of the number of birds sighted or heard during the fruit bat observation periods, with an effort being made not to count the same bird twice. Ninety-eight observation periods conducted between October 1978 and July 1979 at the five areas that were systematically surveyed were analysed for possible associations between fruit bats and fruit-eating birds with two-by-two chi-square tests between fruit bats and each type of bird. For species pairs that were shown to be associated by the chi-square test (at $P< .05$), a coefficient of association was calculated to determine the degree and direction of association. This coefficient can have a minimum value of - 1.0 (negative association) and a maximum value of + 1.0 (positive association). Following are the results:

			x^2	Significant	Coefficient of Association
Fruit Bat	Vs.	Drongo (*Discrurus macrocercus*	.000018	No	-
Fruit Bat	Vs.	Philippine Turtle Dove (*Streptopelia bitorquata*)	8.42	Yes	+ .293
Fruit Bat	Vs.	Marianas Crow (*Corvus kubaryi*)	1.19	No	-
Fruit Bat	Vs.	Micronesian Starling (*Aplonis opacus guami*)	9.73	Yes	+ .315
Fruit Bat	Vs.	White-throated Ground Dove (*Gallicolumba x. Xanthanura*	.731	No	-
Fruit Bat	Vs.	Fruit Dove *Ptilinopus roseicapilla*	11.01	Yes	+ .106

Table 6. Frequencies of different types of flight activities and vocalization in the area of a Marianas fruit bat colony.

LOCATION:	BEHIND	WSA				PATI	POINT				
DATES/NO.BATS:	JUNE 28 - 29, 1979/ 50 + Bats					AUGUST 20 - 22, 1979/ 85 + Bats					
BEHAVIOR[a]:	ICF	OCF	OIF	OIF	VOC		ICF	OCF	OIF	IOF	VOC
600-630	5	4	0	0	6	700-800	50	5	1	3	11
630-700	6	2	1	0	8	800-830	57	1	0	2	5
700-730	14	1	0	0	6	830-900	65	2	0	0	2
730-800	7	0	0	0	7	900-930	38	5	0	2	3
800-830	0	1	0	0	1						
830-900	0	0	0	0	0	1000-1030	10	0	0	1	3
						1030-1100	0	1	0	0	0
1400-1430	0	0	0	0	0	1100-1130	1	0	0	0	0
1430-1500	0	0	2	0	1	1130-1200	0	0	0	0	1
1500-1530	0	0	0	0	0	1200-1230	1	0	0	0	0
1530-1500	2	0	0	0	3	1230-1300	0	0	0	0	0
						1300-1330	0	0	0	0	0
1835-1850	5	1	0	0	0	1330-1400	2	1	0	0	0
1850-1905	3	1	0	0	0	1400-1430	0	0	0	0	0
1905-1920	0	0	0	0	10	1430-1500	0	0	0	0	0
						1500-1530	42[b]	0	0	1	0
						1530-1600	10	1	0	0	0

[a] ICF = flights within the colony, OCF = flights outside the colony, OIF = flights from outside the colony to inside the colony, IOF = flights from inside the colony to outside, VOC = vocalizations.

[b] The colony was disturbed by something and 30 bats took to the air at once. They all went back to roost in the same area within 5 minutes.

Black drongos are occasionally seen harassing fruit bats on Guam (Perez 1972, Bruner and Pratt 1979), but there was no significant negative association between these two species in the study areas, suggesting that black drongos do not locally exclude fruit bats. The significant positive association between the introduced Philippine turtle dove and the Marianas fruit bat indicates that this dove is occupying fruit bat habitat. Whether or not there is overlap in food habits remains to be determined. Of the native, fruit-eating birds, the Micronesian starling and the Marianas fruit dove exhibited a significant association with fruit bats in the study areas.

Pteropus tokudae

At Ritidian Point on June 6, 1979 a bat was observed that was about 2/3 the size of a full-grown Marianas fruit bat (*P. mariannus*), had a brownish mantle instead of a buff one, and appeared somewhat brownish over the rest of the body. Perez (1973) states that from a distance it is difficult to distinguish between *P. mariannus* and *P. tokudae*, however, my observation was close range (< 150'), with binoculars and the bat observed fits more closely the description of *P. tokudae* (Tate 1934, Bryan 1939). I inspected two juvenile Marianas fruit bats (one male and one female) being held in cpativity at the Cushing Zoo, and both bats had a bright yellowish buff mantle. Consequently, I believe the sighting at Ritidian Point may have been of an individual of *P. tokudae*, suggesting that this rare species (endemic to Guam) is not yet extinct.

Fruit Bat Imports

Concern about the status of fruit bats in Micronesia is increasing (Bruner and Pratt 1979, Ralph and Sakai 1979). There is no doubt that fruit bats are being over-harvested on several islands and rapidly declining bat populations have been noted on Palau (Robert Owen, personal communication), Yap (Falanruw 1979), and Rota (Wheeler 1979c). The following species and subspecies of *Pteropus* are now involved in bat imports to Guam:

P. mariannus mariannus - Guam, Rota, Aguigan, Tinian, Saipan
P. mariannus paganensis - Marianas north of Saipan
P. yapensis - Yap Islands
P. pelewensis - Palau Islands
P. insularis - Truk Islands
P. molossinus - Ponape
P. edwardsii - Solomon Islands
P. samoensis - Samoan Islands
P. tonganus - Samoa, Fiji, Tonga

The number of frozen fruit bats requested for import to Guam has increased by about 60% from fiscal year 1978 (35,519 requested for 9 months of FY 1978 to 76,191 requested for 12 months of FY 1979) (Table 7). Areas of greater distance from Guam are now being sought as potential fruit bat suppliers (e.g., the Solomon Islands and American Samoa).

The number of fruit bats actually imported to Guam has also increased dramatically (79.9% since FY 1978 - see Table 8). Data on imports from mid-November to mid-March were not available because some records were

Table 7. Numbers of frozen fruit bats requested for import to Guam between July 1, 1978 and June 30, 1979

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
Saipan	347	550	270	377	453	824	360	475	150	549	447	481	5,283
Tinian	160	30	60	10	30	66	136	0	27	0	105	75	699
Rota	25	0	140	1,029	270	398	50	85	10	0	0	0	2,017
Yap	610	1,030	330	590	414	790	700	2,630	3,500	430	820	2,830	14,674
Palau	2,095	3,584	2,325	1,490	4,172	2,435	6,895	4,930	4,735	4,786	9,455	7,252	49,658
Ponape	0	100	100	10	0	0	35	20	0	80	50	0	395
Solomons	0	0	0	0	2,500	0	500	0	0	0	0	0	3,000
American Samoa	0	0	0	0	0	50	0	50	20	0	0	20	140
Truk	0	0	0	0	0	0	0	0	0	100	225	0	325

SUBTOTAL (Saipan, Tinian and Rota): 7,999

TOTAL (All Islands): 76,191

Table 8. Numbers of frozen fruit bats imported to Guam between July 1, 1978 and June 30, 1979.

	July	Aug.	Sept.	Oct.	Nov.*	Dec.*	Jan.*	Feb.*	Mar.*	Apr.	May	June	Total
Saipan	197	191	135	145	156	284	124	163	52	139	69	167	1,822
Tinian	116	0	20	0	15	32	67	0	13	0	75	5	343
Rota	15	0	0	422	98	144	18	31	4	0	0	0	732
Yap	379	455	130	30	118	225	199	239	227	180	250	464	2,896
Palau	1,265	1,935	2,146	1,100	2,617	1,527	1,502	1,680	1,840	670	1,145	1,179	18,606
Ponape	0	100	30	0	0	0	20	11	0	60	0	0	221
Solomons	0	0	0	0	1	0	0	0	0	0	0	0	1

SUBTOTAL (Saipan, Tinian and Rota):	2,897
TOTAL (All Islands):	24,621

*Estimated based on the number of bats requested for importation that month and the percentage of requested bats imported during the rest of the fiscal year.

lost, apparently due to a poor record keeping system at the Department of Agriculture. Bat imports for these months were estimated based on the percentage of requested bats imported during the rest of the fiscal year (July - November and April - June), and the number of bats requested for import each month (November - March). The number of bats imported from the Northern Marianas Commonwealth has increased by about 7% since FY 1978. The major increase in bat imports has been in bats originating in Palau. Some of the bats imported to Guam from Saipan are Palauan bats (Pedro Dela Cruz, personal communication), Yap bats, or individuals of the protected subspecies P. m. paganensis, being transshipped to Guam. There are not sufficient numbers of live bats on Saipan to support any harvest (Wheeler 1979c).

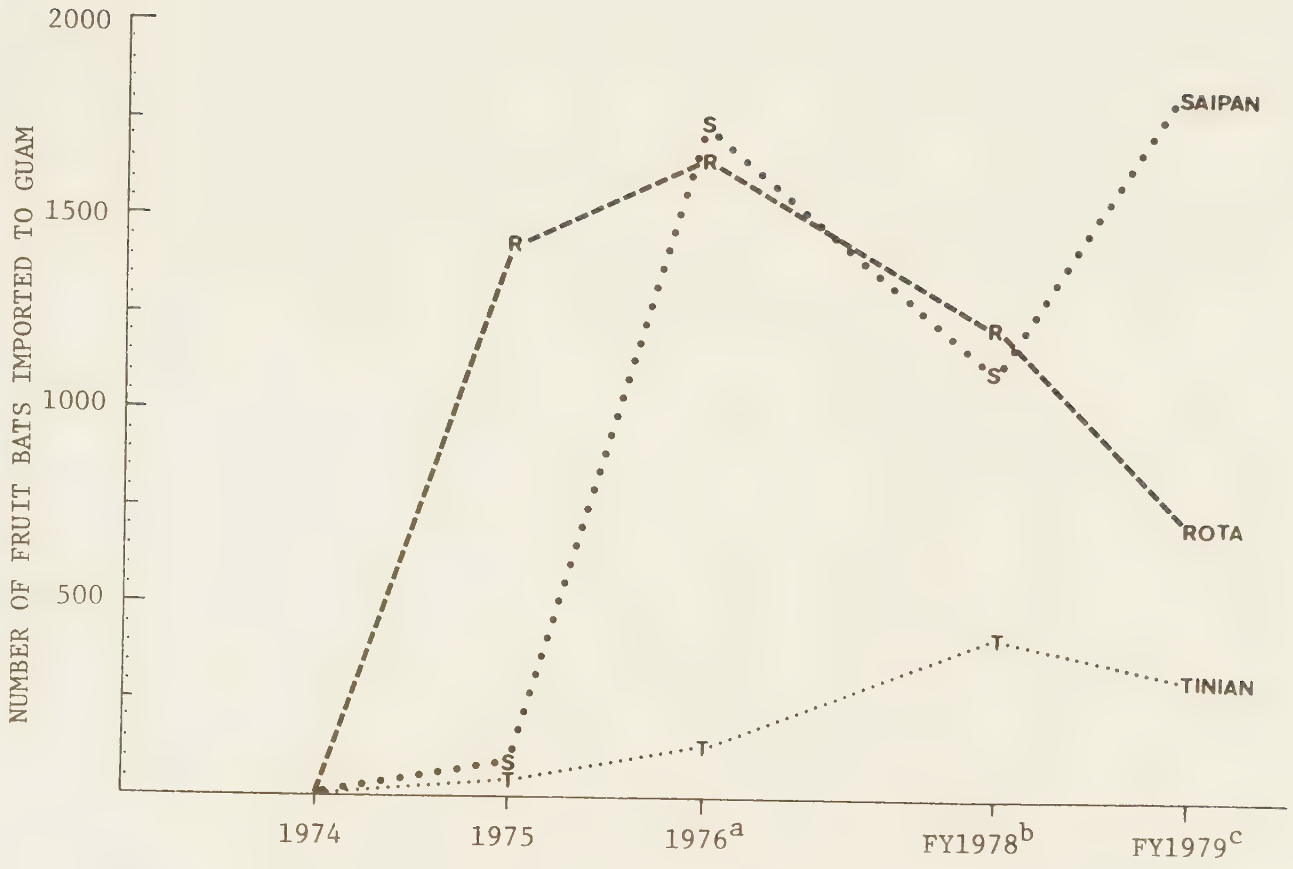
Five-Year Trend in Bat Imports

Fruit bat imports to Guam began in the early 1970's after the local population became severly depleted and fruit bat hunting was made illegal on Guam. Individual consumers and entrepreneurs began investigating other islands with direct air traffic to Guam as sources of this local delicacy. The northern Mariana islands of Rota, Tinian and Saipan became popular sources for individual consumers, while wholesalers sought out sources on these islands plus Palau and Yap. Some individuals traveling to Guam from Truk, Ponape and American Samoa on business or pleasure probably decided to import some fruit bats incidentally. A pattern has emerged over the five-year period (1974-1979) during which bat imports have been monitored. Imports from Rota and Tinian have peaked and are now declining (Figure 3) since the fruit bat populations on these islands are now depleted (Wheeler 1979c). Bat imports from Saipan peaked in 1976, but now show a renewed increase probably as a consequence of transshipment of bats originating in Palau, Yap, Pagan and other islands north of Saipan. Bat imports from Yap also appear to have peaked (Figure 4), possibly as a consequence of over-harvesting. Imports from Palau, however, continue to increase.

As near-by sources diminish, some entrepreneurs are investigating more distant sources without direct air traffic to Guam such as the Solomon Islands or American Samoa, but as yet such sources have not substantially contributed to the total number of fruit bats imported.

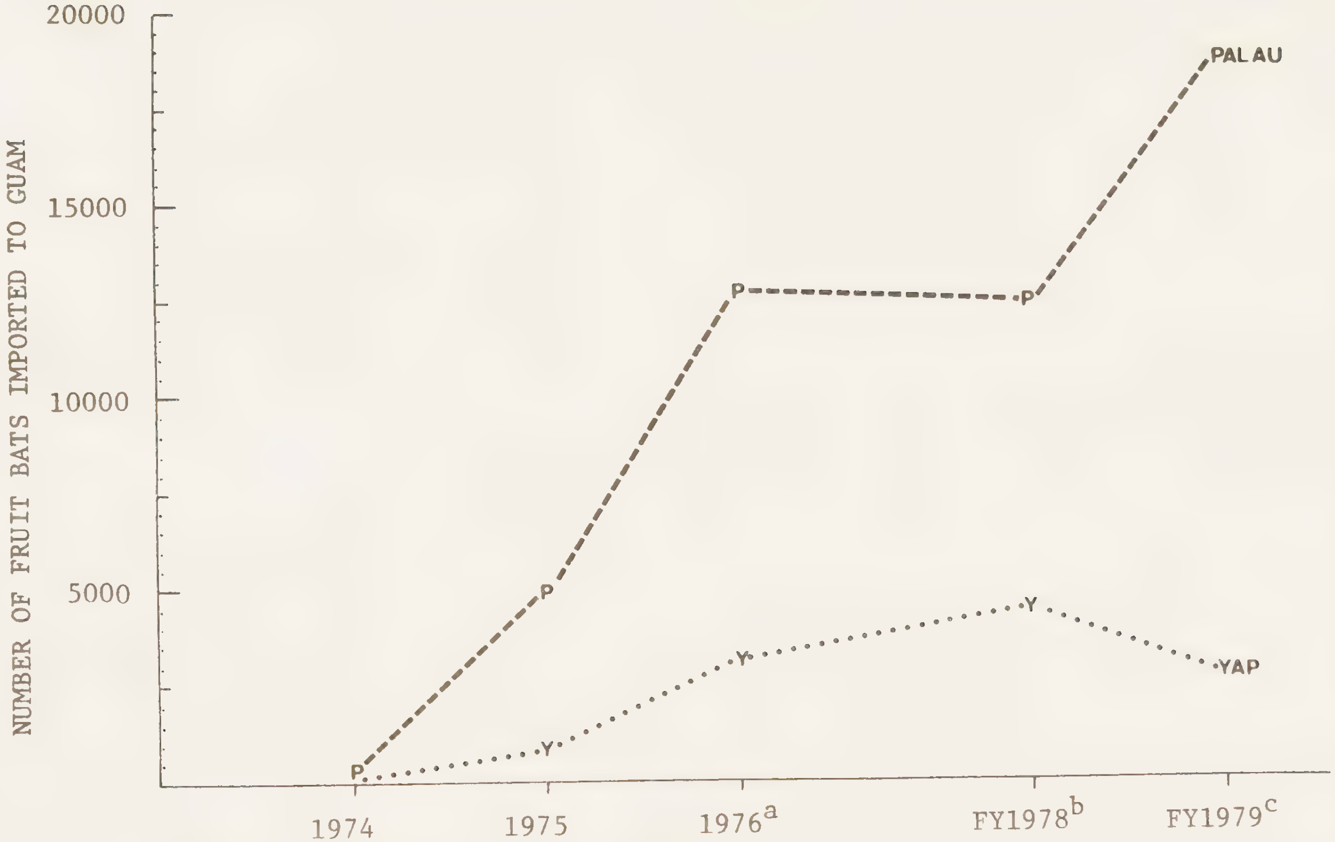
Legal Protection

In fiscal years 1977 and 1978 recommendations concerning conservation of fruit bats were made to the Trust Territory administration and the Government of the Northern Marianas Commonwealth (AWR 1977, 1978). The Northern Marianas Commonwealth has established Aguigan as a wildlife sanctuary, and has declared a temporary moratorium on the taking of fruit bats on islands north of Saipan, but has not established any restrictions on bat imports and has not adequately enforced regulations concerning the taking of fruit bats (Wheeler 1979a, 1979c). The Trust Territory administration has taken no action on these recommendations, presumably for reasons explained by Owen (1969). The Division of Aquatic and Wildlife Resources investigated the possibility of invoking the Lacey Act to curtail fruit bat imports to Guam (this act prohibits interstate transporting of certain wildlife species including fruit bats). However, upon careful reading of the law and consultation with Guam's Attorney General's Office, it was concluded that the act applies



[a] Annual rate based on ten months data. [b] Annual rate based on nine months data.
[c] July 1978 - June 1979.

Figure 3. Five-year trend in fruit bat imports to Guam from Rota, Tinian and Saipan.



[a] Annual rate based on ten months data.

[b] Annual rate based on nine months data.

[c] July 1978 - June 1979.

Figure 4. Five-year trend in fruit bat imports to Guam from Palau and Yap.

to live fruit bats and not dead ones. Subsequent to the fruit bat surveys of Rota, Tinian and Saipan (Janauary-March 1979), it was realized that the Marianas fruit bat is in serious danger of extinction throughout its range. A proposed Executive Order was drafted for signing by the Governor of Guam which would have established the following regulations:

1. Marianas fruit bats (Pteropus mariannus) may not enter Guam from any island, including the islands of the Commonwealth of the Northern Marianas, for purposes of retail sale or trade, wholesale sale or trade, personal consumption or as gifts for personal consumption.

2. Fruit bats of other species may enter Guam in a frozen state from islands other than the Northern Marianas, but must be accompanied by a Certificate of Origin signed by competent legal authority on the island of origin stating that the bats in question were legally harvested.

3. Marianas fruit bats may not be bought, traded, sold or possessed in any form without special written permission from the Director of Agriculture.

4. Fruit bats of other species may be sold in public places only when the Certificate of Origin has been signed by a legal official of the place of origin, counter-signed by Guam's Director of Agriculture, and posted in a conspicuous place at the establishment of sale.

5. The fee for issuance of a permit to import fruit bat species other than the Marianas fruit bat shall be five dollars ($5.00).

6. The number of fruit bats allowed on any such permit may not exceed fifty (50) bats.

7. All monies collected under authority of this order shall be deposited in the Conservation Fund and shall be used for the purpose of enforcement and administration.

Submission of these regulations to the Governor's Office was preceded by news releases, a public hearing and public interviews concerning the current state of the Marianas fruit bat. The Governor's office has refused to approve the regulations in any form and has stated that the matter is closed for discussion.

During this fiscal year the 15th Guam Legislature considered and passed a new Endangered Species Act. A preliminary draft of the Act included a stipulation that fruit bats will be excluded from endangered species status under the Act, however, this clause was dropped when it was pointed out that it was contrary to federal law. The act that passed stipulates that a list of proposed endangered species be made by the Department of Agriculture, and that the list must be approved by the village commissioners and the Legislature. Protection of the Marianas fruit bat under this local Act will be sought, however, under the present political climate it seems unlikely that additional local protection will be forthcoming.

On the federal level, the Marianas fruit bat and the little Marianas fruit bat (P. tokudae) were both proposed for endangered status under the Federal Endangered Species Act of 1973. During this report period the Federal Government solicited comments from interested persons to ascertain whether these species merit review. The Division proposed critical habitat via the Governor's office and submitted additional fruit bat status reports completed since the initial proposals for endangered status.

Bibliogrpahy

Three computer searches of the scientific literature on fruit bats have been acquired. In addition, some hand searching is being done in areas of deficiency. The fruit bat bibliography will be completed in FY 1980.

Emballonura

Several caves were investigated for the presence of the insectivorous bat (Emballonura semicaudata Peale) which historically occurred on Guam (Safford 1905, AWR 1971). No bats were seen in or near any of the caves investigated, which included two caves near Tarague Pump House Station No. 4, one cave near Ritidian Point, and one cave near the Naval Hospital. Other caves will be investigated in FY 1980 and an assessment of the status of this bat on Guam will be made. Several caves on the Naval Magazine were historically occupied by Emballonura as recently as 1971 and remain to be investigated. In addition, a high school teacher reported seeing what may have been a bat in Talofofo cave about a year ago. If any of these insectivorous bats still exist on Guam, consideration should be given to seeking endangered species status and delineating critical habitat.

Illegal Hunting

There were three known incidents of illegally hunting fruit bats during this report period. All three incidents occurred in the Tarague Beach area, and during one incident two poachers escaped into dense vegetation during the night, leaving behind a dead female Marianas fruit bat in a game sack. Even just a few such incidents are serious cause for alarm because the population is so depleted and because the reproductive potential of fruit bats is so low.

Funding has been secured from the Coastal Zone Management Program to add one officer and one vehicle to the Enforcement Section and to add one full-time position devoted towards conservation education to the Division staff. This funding will allow for a greater effort to be devoted towards enforcing laws protecting fruit bats and towards developing in the local people a conservation ethic necessary for fanihi conservation.

A Profile of Fruit Bat Importers

Thirty-eight fruit bat importers were surveyed by questionaire during the first half of 1979 in order to determine the economic benefits derived from importing bats and to find out other characteristics of importers. The number of bats that were being requested for importation one time ranged from 4-230 bats with a mean of 47.0 ± 8.9 bats. The purpose of importing, maximum cost at origin, and the frequency of importing were also determined (Table 9).

Table 9. Characteristics of fruit bat importers.

Purpose for Importing	No. Responses	Percent
Personal consumption	29	70.7
For sale to friends	4	9.7
For a party	3	7.3
For sale to retail store	2	4.9
No answer given	2	4.9
For sale to wholesaler	1	2.4

Maximum cost of bats at origin Island	No. Responses	Mean Cost ($U.S.)	Range ($U.S.)
Palau	5	2.95	0-4.50
Yap	4	3.75	0-10.00
Saipan	7	5.86	0-15.00
Tinian	1	0	-
American Samoa	1	15.00	-

Selling Price on Guam (N=5): Mean = $6.60; Range $5 - $10.

Frequency of Importing	No. Responses	Percent
Less often than once a year	15	42.9
Once every 6 to 12 months	8	22.9
More often than once a month	5	14.3
Once every 3 to 6 months	4	11.4
Once every 1 to 3 months	3	8.6

Ethnic Affiliation	No. Responses	Percent
Chamorro	26	70.3
Palauan	8	21.6
Yapese	2	5.4
Caucasian	1	2.7

From the survey it can be seen that most fruit bat importers are Chamorro who are trying to obtain bats for personal consumption and who bring in bats less often than once every six months. There are a small number of importers engaged in the retail or wholesale trade of fruit bats, who typically bring in bats more often than once every six months. When bat importers were asked whether they thought restrictions on importing fruit bats are necessary, 47.4% replied no, 36.8% replied yes, and 15.8% gave no reply.

MANAGEMENT RECOMMENDATIONS:

I. The bat monitoring study and collection of ecological and life history data on Guam should be continued.

II. Rota, Tinian and Saipan should be surveyed for fruit bat numbers and distribution at least once a year until the Northern Marianas Commonwealth has established a wildlife management program.

III. Fruit bat imports should continue to be monitored. Since the Trust Territory government is being dissolved, the new governments of Palau and the Federated States of Micronesia should be made aware of fruit bat imports from these nations and of problems with conservation of fruit bats.

IV. There should be an immediate cessation of imports of *P. mariannus* to Guam, a moratorium on importation of *P. yapensis* to Guam and limitation on importation of *P. pelewensis* to Guam to 1200 bats annual.

V. Some of the efforts of the new staff member working on conservation education should be devoted towards developing a conservation ethic for fruit bats.

VI. The Enforcement Section should devote more time towards patrolling the Tarague beach area for illegal fruit bat hunters. Recommendation should be made to AAFB administration to prohibit coconut crabbing and fruit collecting in this area since these excuses are commonly used by poachers to gain access.

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Report prepared by: Michael E. Wheeler

Note: Plant nomenclature in this report follows Stone, B. 1970. The flora of Guam. Micronesica 6:1-659. Since the flora has been published, however, the names of the following two plants have been changed: Ochrosia oppositifolia to Neisosperma oppositifolia, and Bleekeria Mariannensis to Ochrosia mariannensis.

A fruit bat in flight behind WSA, AAFB.

A fruit bat merchant examining his stock.

Appendix

Proposals to place the Marianas and little Marianas fruit bats on the Federal Endangered Species List.

Marianas Fruit Bat, Pteropus mariannus mariannus (Desmarest)
Order: Chiroptera
Family: Pteropodidae

Distinguishing Characteristics:

A relatively large fruit bat. The back and rump are blackish seal-brown, slightly sprinkled with silvery gray-white hairs. The breast, belly and flanks are seal-brown, which may fade to chocolate, slightly mixed with silvery hairs. The mantle and sides of the neck are ochraceous-buff. The crown is dark brown, mixed with buffy hairs, darker on the sides of the head, and darkened to seal-brown on the chin and throat. The forearm is over 12.5 cm long and the skull nearly 3.75 cm wide.

Present Distribution:

Occurs throughout the Mariana Islands, but now restricted on Guam to the northern area.

Former Distribution:

Probably the same.

Status:

Endangered on Guam. Decreasing in numbers on Rota and possibly on northern Mariana Islands.

Estimated Numbers:

Less than 100 on Guam. Numbers unknown for the other Mariana Islands.

Breeding Rate in the Wild

One young per year, rarely two. Age at sexual maturity - 3 years.

Reasons for Decline:

Two major factors relating to the decrease in populations are habitat destruction and illegal hunting on Guam. Habitat destruction on Guam has resulted from increased housing, commercial development, and typhoons. The fruit bat is a very popular delicacy on Guam, and although the hunting season was closed on February 21, 1973, illegal hunting continues relatively unabated. To supplement the now scarce Marianas fruit bat, importations of it and other fruit bat species to Guam have increased tremendously over the past three years. Frozen Marianas fruit bats are now being imported to Guam from Rota, Tinian and Saipan, while related species are being imported from Palau, Yap and Truk. In fiscal year 1976 alone, the Department of Agriculture on Guam received requests for permits to import 43,231 pounds of fruit bats from the Trust Territory. Approximately 31% of the demand was filled. Fruit bats weigh ½ to 1 pound, thus the demand represents over 40,000 bats/year. From October, 1977 to June, 1978 a total of 14,752 frozen fruit bats were imported to Guam. Of these, 2,032 bats were imported from the islands of Rota, Tinian and Saipan. A monthly average of 1,639 frozen fruit bats were imported to Guam for sale as food for this nine month period.

Protective Measures Already Taken:

Closure of the hunting season on Guam. The island leaders of Rota, Tinian and Saipan were informed of the drain on their fruit bat populations. The Northern Marianas Legislature has passed a one-year moratorium on the capturing or taking of fruit bats (Public Law 5-21, September 9, 1977), on the islands north of Saipan.

Measures Proposed:

Survey of existing habitat and populations; studies of life history and ecology; transplanting and reintroduction on Guam; attempt captive propagation; an extensive public awareness campaign; acquisition of critical habitat; increased law enforcement; permit taking on Northern Marianas by natives in traditional ways only for actual subsistence; prohibit commercialization elsewhere.

Number in Captivity:

Unknown; one reported.

Breeding Potential in Captivity:

Unknown

Remarks:

The fruit bat population on Guam has been declining for at least 17 years. From 1961 to 1968 systematic surveys were conducted in four prime fruit bat habitat areas on Guam with the following results:

FY:	61-62	62-63	63-64	64-65	65-66	66-67	67-68
Bats/100 Acres:	80.0	40.0	29.8	11.2	8.5	10.3	21.0

Following 1968 bat data were not collected systematically, however records were kept of sightings of large colonies and small groups of bats. The following is a summary of these sightings:

FY	No. of Colonies Sighted	Total No. Bats in Colonies	No. of Small Groups Sighted	Total No. Bats in Small Group	Total No. Bats Seen	Estimated Population
68-69	3	1,000			1,000	
69-70	4	No estimate			?	
70-71	2	180	2	16	196	
71-72	2	550-650			550-650	
72-73	1	500-600			500-600	less than 1,000
73-74	0	0			0	
74-75	1	50			50	
75-76	0	0			0	less than 100
76-77	0	0			0	
77-78	0	0	1	4	less than 12	less than 100

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Little Marianas Fruit Bat, Pteropus tokudae Tate
Order: Chiroptera
Family: Pteropodidue

Distinguishing Characteristics:

Its color is described as near mummy brown, lightened to Vandyke brown posteriorly, and almost lacking the sprinkling of whitish hairs of P. mariannus. It is smaller than P. mariannus, with a forearm less than 10 cm and the skull less than 2.5 cm wide. The mantle is near Mars brown, becoming paler anteriorly and merging with the mottled bister and gray of the head; sides of mantle near russet; sides of neck cinnamon buff, the modified hairs of the neck tufts warm buff. Color beneath is mummy brown in the abdominal region, paling through Prout's brown on the chest to cinnamon buff on the neck, and darkening again to mummy brown on the throat and chin. The ears are prominent with rounded tips.

Present Distribution:

Recorded only from Guam.

Former Distribution:

Probably the same.

Status:

Extremely rare, possibly extinct.

Estimated Numbers:

In-the-field differentiation of P. mariannus and P. tokudae is very difficult, but of over 100 fruit bats collected and examined on Guam since 1963, only one was a P. tokudae. Since the present population of fruit bats on Guam is estimated at less than 100, probably only a few if any of these bats are P. tokudae.

Breeding Rate in the Wild:

Unknown.

Reasons for Decline:

Illegal hunting and loss of habitat are the two most significant factors responsible for the decline. Loss of habitat has resulted from extensive urbanization and destruction caused by typhoons. Urbanization is continuing at a rapid pace.

Protective Measures Already Taken:

Closure of the hunting season on fruit bats on February 21, 1973.

Measures Proposed:

Survey of existing fruit bat habitat and populations; an extensive public awareness campaign; acquisition of critical habitat; increased law enforcement.

Number in Captivity:

Unknown, none reported.

References

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JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT TITLE: Guam Fish and Wildlife Investigations

PROJECT NO.: FW-2R-16

JOB NO.: W-6

JOB TITLE: Study of the Guam Pig

Period Covered: July 1, 1978 to September 30, 1979

SUMMARY:

The number of legal pig hunters has declined for the third consecutive year, while the effort required to take one pig has increased by 14.7% since 1976. The mean number of days spent hunting per pig hunter has more than doubled since 1976 (4.6 to 9.5 days/hunter), while hunter success increased from 41.7% to 54.4% over the same two year period.

BACKGROUND:

The wild pig (*Sus scrofa*), one of Guam's two "big game" animals, provides valuable recreation in the form of hunting for both residents and transient military personnel, and is sought after as a food resource.

The Guam wild pig was introduced by the Spanish sometime during their three hundred year colonial rule. Carano and Sanchez (1964) indicate that native Chamorros did not eat meat, at least prior to Spanish rule. Guam was used by the Spanish as a rest stop for Spanish galleons traveling between Manila, Philippines and Acapulco, Mexico. Presumably the Spanish stocked the island with "provisions", including pigs.

Starting in the 1920's the Department of Agriculture brought in some domestic strains of pig. Some of these may have escaped and intermixed with the wild pigs present. During the Japanese occupation from 1941 to 1944, many domestic pigs were released by the local people to prevent their confiscation by the Japanese Army. The intermixing of domestic and wild pigs undoubtedly continues today since many people allow their domestic pigs to run loose.

Because of this intermixing of wild and domestic pigs and in the absence of definitive studies, it is assumed that the species of wild pig on Guam is *Sus scrofa*.

Two factors have affected the wild pig population on Guam during recent years: hunting and habitat loss. Prior to 1964, wild pigs were not included on the game list and were hunted all year with no limit. In 1964 pigs were declared a game animal; the season was year-long with a limit of one pig per day. In 1973, based on evidence compiled by the Division, the wild pig season was reduced to a three month period, October to December. The limit continued at one pig per day until 1978, when it was reduced to 10 per season. In addition to the legal hunting pressure on pigs, poaching is a serious problem. It is difficult to estimate the extent of illegal hunting, but judging from the number of incidents reported by Conservation Officers and Security Police it is probably considerable. Some habitat loss on Guam is attributed to natural causes, especially typhoons, however, most of the recent loss is due to human impact. Within the last 10 to 15 years, Guam has experienced rapid economic growth, for some years at the rate of 20-25% (Bureau of Planning 1978). Land clearing in connection with this boom has reduced the amount of wildlife habitat, particularly in the northern half of the island. As a consequence of economic and demographic expansion, the amount of wild pig habitat has been decreasing, however, several areas of potentially good habitat still exist. In the southern part of Guam, prime pig habitat consists mainly of riparian forests in the interior regions and a narrow belt of forest along sections of the coast. In the central region of Guam, excellent pig habitat is located in the Fena Lake area on the U.S. Naval Magazine. Although hunting is not allowed on the Magazine, incidents of illegal hunting are numerous. In the northern part of Guam, Northwest Field provides good habitat for the wild pig, and weekend hunting is allowed in this area during the hunting season. In addition, the limestone coastal forests in the northern region provide quite good pig habitat.

In order to accurately assess the impact of the above factors on the wild pig population, it is necessary to understand as completely as possible the ecology of the pig. Once this basic information is known, intelligent management decisions can be made. The Division started systematically collecting such data in 1967. The basic objective of this study was to gather data on the biology and ecology of wild pigs including observations on population trends. These data were collected to formulate management guidelines for the wild pig population on Guam, so that a relatively stable population could be maintained. General techniques used to gather these data included roadside counts and observations, reports from hunters, and maintenance of a captive population of wild pigs for three years.

This study was reported in the Annual Progress Reports of the Division (AWR 1967-1978). A draft comprehensive report on this study was prepared in 1977 but the editing and revision process was never completed. The report is currently being completely revised, and will be supplemented with additonal data to prepare a status report that identifies management and research needs.

Certain areas of needed work are known at this time. The bulk of fieldwork on pigs in the past has been concentrated on military lands. There is a need to assess pig populations in other areas of the island, particularly in the south, where pigs may currently be under-harvested and where crop damage by pigs is a common complaint. Increased management activities in the south on non-military lands could work to benefit both farmers and recreational hunters.

Research is needed on movement patterns and home range size of wild pigs, on food habits, and on census and survey techniques. These areas were not addressed in detail in the previous wild pig study, and consequently must be addressed in future efforts to develop a management plan for wild pigs.

OBJECTIVE:

The objective of this study is to develop a species management plan that results in sustained yield management of wild pigs.

PROCEDURES:

I. Analyze hunter report card data to estimate hunter take, the extent of the hunting effort and the trend in pig hunter success.

II. Evaluate hunter check station data concerning pig take and pig hunter effort.

III. Investigate pig damage complaints and make recommendations to alleviate such damage.

IV. Initiate a literature review of wild pigs (Sus scrofa).

V. Prepare a status report based on past manuscripts and reports of work conducted under this job.

VI. Identify management and research needs and make recommendations for future work.

FINDINGS:

Hunter Reports and Hunter Harvest Data

The estimated number of legal pig hunters has declined for the third consecutive year, while the effort required to take one pig has increased from 5.8 hunter days in 1976 to 6.8 hunter days in 1978 (Table 1). Coincident with this increase has been an increase in the mean number of days spent hunting by pig hunters, which has more than doubled since 1976 (4.6 days/hunter) to 9.5 days/hunter for 1978. Consequently, it is not surprising that pig hunter success has also increased: 41.7% in 1976, 50.0% in 1977 and 54.4% in 1978.

An equivalent of 796 eight-hour days were spent hunting at Northwest Field (NWF) and the Naval Communications Area Master Station (NCS) during the pig and deer season. On the basis of a post-season hunter survey (see below) approximately 71.9% of the 796 days of hunter effort may be considered as pig hunter effort. It follows that approximately 40.7% of the estimated total pig hunting effort took place on these two military installations. This effort accounted for a legal hunter take of 81 pigs or 38.9% of the estimated legal kill.

Harvest data (Table 2) show that the mean reported weights of adult pigs taken at Northwest Field were lower than island-wide statistics, however, the reverse was true of pigs taken at NCS. Island-wide harvest data suggest that a majority of pig kills are boars and this pattern was repeated in harvest data from NCS and NWF. This result could be a consequence of one or more of the following: an unequal sex ratio, hunters are selectively taking boars, or boars have a greater probability of being taken. The mean

Table 1. 1978 Pig Hunter Report Data.

a.	Percent of 32 reporting hunters who hunted pigs:	68.7%
b.	No. of reporting hunters who hunted pigs:	22
c.	No. of pigs taken by 22 hunters:	31
d.	Total No. of licensed hunters:	313
e.	Estimated No. of pig hunters (a x d):	148
f.	Estimated No. of pigs taken by 148 hunters (e x $\frac{c}{b}$):	208
g.	No. of successful reporting pig hunters:	12
h.	Percent of reporting pig hunters who took pigs:	54.5%
i.	No. pig hunter days reported by 22 hunters:	210
j.	Average no. days each hunter spent pig hunting (i/c):	9.5
k	No. hunter days to take one pig:	6.8
l.	Estimated total number of legal pig hunter days (e x i):	1,406
m.	No. pigs seen by 22 hunters:	253

Table 2. Hunter Harvest Information on Pigs.

LOCATION	CLASS	No. Reported Taken	No. With Weights	Weight Range (Kg)	Mean Weight (Kg)
Island-wide	Boars	16	12	18.2-79.5	42.8
Island-wide	Sows	13	8	13.6-38.6	25.5
Island-wide	Piglets	2	2	11.4-20.5	15.9
NWF	Boars	19	16	16.4-65.9	30.6
NWF	Sows	5	3	18.2-27.3	22.0
NWF	Piglets	4	2	-	3.2
NWF	Unclassed	14	12	18.2-90.9	32.0
NCS	Boars	11	9	22.7-79.5	49.2
NCS	Sows	6	6	20.5-90.9	37.1
NCS	Piglets	1	1	-	6.8
NCS	Unclassed	19	15	13.6-45.5	25.3

reported weight of pigs taken at NWF in fiscal year 1978 was 50.5 kg, and although weights are just estimated, the weights reported for NWF this fiscal year are considerably lower.

Lower body weights and an increasing trend in hunter effort required to take one pig suggest that pig numbers may be declining in some areas, howerver, a suitable indicator of abundance remains to be developed. Pigs are occasionally sighted during night spotlight counts of deer and during other wildlife field work, but this method is not a reliable technique for estimating abundance due to the nature of the habitat types in which pigs are usually found on Guam (i.e., dense vegetation). The observations of Giffin (1972) on censusing pigs in rain forest habitat in Hawaii probably apply to most areas occupied by pigs on Guam.

Post-Season Survey

A post-season hunter survey was conducted to determine the locations where pigs were taken, and the relative amounts of hunter effort devoted to different areas (Table 3). Forty-six respondants filled out the survey form when purchasing a hunting license for the 1979 season. Of these, 31 hunted in the 1978 season and 27 had hunted for pigs. In this survey 14 successful pig hunters (51.9% hunter success compared to 54.5% hunter success on Table 1) reported taking 11 pigs from NWF and 18 pigs from NCS. Pigs were not reported taken from any other area on the island. All reported pig hunting took place on NCS, NWF AAFB or the Bolanos Conservation Area (Table 3).

Final Report

Some progress has been made on completing the redrafting of the final report manuscript of this job, and it is expected that the report will be finalized next fiscal year.

Literature Review

A computerized literature search of *Sus scrofa* (feral only) was initiated this fiscal year and should be completed next fiscal year.

RECOMMENDATIONS:

Further work is required to establish an index of abundance for pigs, or some appropriate population sampling method. A more complete analysis of the problems and requirements for managing wild pigs on Guam is currently undergoing redrafting.

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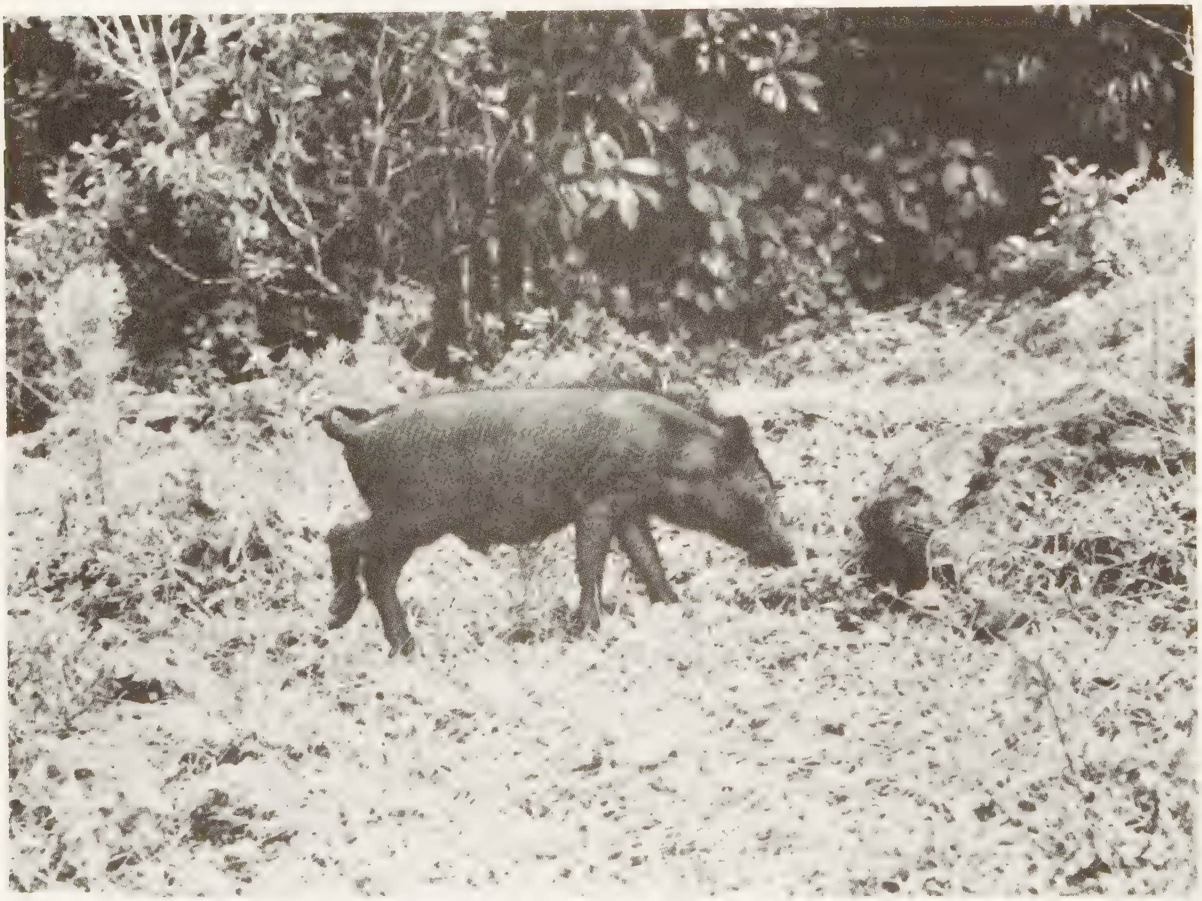
Report prepared by: Michael E. Wheeler



A Guam wild pig in typical habitat

Table 3. Hunting effort by area and by species being hunted.

AREA	Simulataneous Pig and Deer Hunting(hr)	Deer Hunting Only(hr)	Pig Hunting Only(hr)	Dove Hunting Only(hr)	Not Specified (hr)	Monitor Lizard (hr)	Rodents (hr)	Dogs (hr)	Total (hr)	Percent	Percent Specified
NCS	496	302	128	0	84	30	0	0	1,040	54.6	61.3
NWF	240	8	10	36	118	0	0	0	412	21.6	24.3
AAFB	52	100	150	0	9	0	0	0	211	11.1	12.5
Anao	0	24	0	0	2	0	0	0	26	1.4	1.6
Cross Island	0	4	0	0	0	0	0	0	4	.2	.2
Bolanos	0	0	2	0	0	0	0	0	2	.1	.1
Not Given	0	100	0	98	0	10	1	1	210	11.0	
TOTAL	778	538	290	134	213	40	1	1	1,905		
PERCENT	41.4	28.2	15.2	7.0	11.1	2.1	.05	.05			

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

TERRITORY:	Guam	PROJECT TITLE:	Guam Fish and Wildlife Investigations
PROJECT NO.:	FW-2R-16		
JOB NO.:	W-10	JOB TITLE:	Habitat Improvement for Wildlife

PERIOD COVERED: July 1, 1978 to September 30, 1979.

SUMMARY:

Five water catchments were installed in Northwest Field and a limited amount of planting was done by Youth Conservation Corps enrollees between July and September, 1978. This project was inactive during the remainder of the segment.

BACKGROUND:

The decline in Guam's endemic wildlife species is attributed largely to the massive changes that have taken place in the availability and quality of habitat in recent years. The combined effects of World War II, rapid urbanization, and frequent typhoons have greatly reduced the original native forest on the northern limestone plateau. It is thought that populations of wildlife, particularly of native species such as the fruit dove, may benefit from the planting of desirable food plants in areas where food may be limiting. Other habitat improvements, such as the installation of nest platforms, may also benefit native birds.

Because of the permeable nature of the northern limestone plateau on Guam, water may also be a severe limiting factor during the dry season. The installation of water developments (guzzlers) may benefit a number of wildlife species found in the area, including doves, pigs and deer.

OBJECTIVES:

To increase wildlife populations by improving available habitat.

PROCEDURES:

I. Establish experimental plantings of various food plants, including fruit-bearing trees and shrubs, that may be used by wildlife.

II. Construct and install water developments (guzzlers) in selected areas of the northern limestone plateau where water may be a limiting factor to wildlife populations.

FINDINGS:

This project was funded largely by the Youth Conservation Corps (YCC) program administered through the Guam Department of Agriculture in 1978. Most of the material and labor cost was borne by YCC, with the Division providing general supervision to the project.

YCC enrollees constructed and installed five multi-purpose water troughs or "guzzlers" in Northwest Field. The "guzzlers" were constructed of split 55 gallon drums welded together to form a trough with a 55 gallon capacity. These troughs were installed in the ground and covered with a "v-shaped" roof that doubles as a rainfall catchment and a shade to reduce evaporative loss.

Periodic visits to the "guzzlers" have revealed no direct evidence of wild-life use, though wild pig sign is common in the vicinity of the guzzlers and pigs have been observed nearby on several occassions. The "guzzlers" have remained full of water year-round.

The planting program consisted of spot plantings of fruit bearing trees and shrubs that are known to be prime foods of the Marianas Fruit Dove (*Ptilinopus roseicappillus*). These included Panama Cherry (*Muntingia colabura*), Papaya (*Carica papaya*), Ink Berry (*Cestrum diurnum*), and Bitter Melon (*Momordica charantia*), among others. Though some of these plants have become established, it is considered unlikely that a significant increase in wildlife populations will result because of the relatively small area that was successfully planted.

RECOMMENDATIONS:

1. Discontinue this Job and re-document it as a Development Project should further habitat improvement work be desired.

Report prepared by: Robert D. Anderson

One of five "guzzlers" constructed in Northwest Field.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

TERRITORY: Guam

PROJECT NO.: FW-2R-16

JOB NO.: W-11

PROJECT TITLE: Guam Fish and Wildlife Investigations

JOB TITLE: Preparation for a Development Project to Establish Game Management Areas

PERIOD COVERED: July 1, 1978 to September 30, 1979.

SUMMARY:

This project was inactive during most of this report period.

BACKGROUND:

The Government of Guam has established four Conservation Areas, totaling over 5,000 acres, to be managed for wildlife conservation and to be available to the public for hunting and other recreational uses. Though these areas have existed for several years, they are little used by the public because of a general lack of access. The lack of access has also been a major obstacle to the implementation of proper management of the wildlife and wildlife habitat of the Conservation Areas.

Most hunting activity on Guam currently occurs on the military lands on the northern third of the island. Because of the nature of these lands and the security restrictions imposed by the military, only a limited number of hunters can be accommodated. As the population of Guam grows and more leisure time becomes available to the populace, the hunting pressure may become so great that the military land alone cannot meet the demand. Also, the wildlife populations on military lands are a limited resource that cannot be expected to provide for the total projected future hunting demand.

The problem is to develop adequate access to these conservation areas to allow for the implementation of biologically sound management of the wildlife and wildlife habitat in the areas as well as to provide the opportunity for public hunting and other recreational use of the conservation reserves. Because of its size and potential for management and recreational use, including hunting, the prime emphasis is on development of the Bolanos Conservation Area.

Recent developments include a legislated change in jurisdiction over Conservation Areas and the inclusion of both the Bolanos and Cross Island Conservation Areas in the proposed Territorial Seashore Park. Public Law 12-209, passed by the 12th Guam Legislature in 1974, repealed that section of the Government Code giving the Department of Agriculture jurisdiction over Conservation Areas. Jurisdiction over these areas was transferred to the Department of Parks and Recreation, though management responsibilities for wildlife remain with the Department of Agriculture.

OBJECTIVES:

To prepare the necessary documents required to initiate a project agreement for a wildlife development project.

PROCEDURES:

1. Draw up all necessary documents as specified in the Federal Aid Manual to initiate a development project agreement.

II. Contract an engineering firm to draw up plans and specifications.

FINDINGS:

A Territorial Seashore Park Management Committee has been established, consisting of the Departments of Parks and Recreation, Agriculture, Land Management, the Bureau of Planning, and the Guam Environmental Protection Agency. As a member of this Committee, we maintain close liason with the Department of Parks and Recreation regarding the development of the Park, and will work closely with them in designing and planning this access development project. Close cooperation between both departments is necessary to ensure that the development of the proposed Seashore Park is compatible with the original intent of the Conservation Areas and to ensure the protection and wise management of the wildlife resources in these areas.

An Application for Federal Assistance and Project Agreement for a wildlife Development Project including the development of public access to the Bolanos Conservation Area was completed and approved during this segment. All future work will be done under this Development Project. Segment 17 efforts will concentrate on preparation of an Environmental Impact Assessment and other necessary documentation.

RECOMMENDATIONS:

1. Maintain a close working relationship with the Department of Park & Recreation and other members of the Territorial Seashore Park Management Committee.

2. Prepare an Environmental Impact Assessment and establish an agreement of understanding with the Department of Parks and Recreation and the Bureau of Planning regarding consistency between this access development project, the Territorial Seashore Park and the Coastal Zone Management Plan.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

TERRITORY: Guam

PROJECT NO.: FW-2R-16

JOB NO.: W-12

PROJECT TITLE: Guam Fish and Wildlife Investigations

JOB TITLE: Manuscript Revision of Previous Guam Wildlife Jobs

PERIOD COVERED: July 1, 1978 to September 30, 1979

SUMMARY:

Two of the manuscripts have been completely rewritten during this segment, and some progress has been made toward completing the others.

BACKGROUND:

Seven draft manuscripts were prepared reporting the results of wildlife studies carried out during the years prior to 1977. Though these manuscripts summarize the results of a number of years of effort and were intended as final reports, they were never completed. The manuscripts contain some valuable infomation but are in need of extensive revision and updating before they can be published.

OBJECTIVES:

To revise, rewrite, and edit as necessary the following seven manuscripts:

1. Life History Study of the Guam Rail (Rallus owstoni).
2. The Doves of Guam.
3. Population Dynamics of Guam Birds.
4. The Guam Deer (Cervus unicolor mariannus).
5. The Status of the Vanikoro Swiftlet (Callocalia vanikorensis) on Guam.
6. The Study of the Wild Pig (Sus scrofa) on Guam.
7. The Status of the Black Frankolin (Francolinus francolinus) on Guam.

PROCEDURES:

Revise, rewrite, and edit as necessary the above manuscripts until an acceptable final report is completed.

FINDINGS:

Wildlife Biologist, J. Mark Jenkins devoted a major effort to completing The Guam Rail manuscript. The manuscript was completely rewritten and supplemented with extensive observations of behavior and feeding ecology made by Jenkins. A paper entitled "Natural History of the Guam Rail", which summarizes nearly twenty years of roadside counts and field notes, has been accepted for publication in Condor.

Working on revising and rewriting the Guam Deer manuscript was also completed during this segment. Wildlife Biologist, Michael E. Wheeler completely rewrote the manuscript, summarizing and analyzing data collected by the Division since 1961 and supplementing that with field observations of his own. His report, entitled "The Biology of the Guam Deer", has been issued as Technical Report No. 2 of the Division.

Plans for completing the remaining manuscripts have been included in the program narratives for Segment 17 studies. The entire wildlife program has been revised to include the preparation of species management plans for selected species, and completion of the status report manuscripts will be an integral part of the program.

The Division has received funds from the Coastal Zone Management Program to implement a public awareness/conservation education program. One of the responsibilities of the person hired for this program will be to edit manuscripts and reports of the Division, and to produce information bulletins on Guam's wildlife resources. It is anticipated that a series of bulletins summarizing the ecology and status of each wildlife species will be produced through this program.

RECOMMENDATIONS:

1. Complete status reports of selected wildlife species as an integral part of developing management plans for these species.
2. Produce a series of bulletins summarizing the ecology and status of selected wildlife species as a part of the CZM-funded conservation education program.

Job Progress Report
Research Project Segment

TERRITORY: Guam

PROJECT TITLE: Guam Fish and Wildlife Investigation

PROJECT NO.: FW-2R-16

JOB NO.: W-13

JOB TITLE: Studies of the Birds of Guam

PERIOD COVERED: July 1, 1978 to September 30, 1979

SUMMARY:

Several species of native birds have shown population declines in roadside counts conducted since 1974 over northern and central Guam. These species include the white-throated ground dove, cardinal honey-eater, Guam rail, rufous-fronted fantail, Micronesian starling, and micronesian kingfisher.

A year-long shorebird survey was completed which consisted of 100 counts and recorded 21 species of the families Charadriidae and Scolopacidae. This survey recorded four migrant shorebirds previously unreported from Guam, and detailed the seasonality and relative abundance of shorebirds on Guam.

Ten of the native birds of Guam were proposed for inclusion on the U.S. Endangered Species List. These proposals were supported by a survey of native birds on Rota, Tinian and Saipan.

A paper on the "Natural history of the Guam rail" has been completed for publication. In addition, field notes on other native birds are being compiled for a manuscript on their life history, ecology, and behavior.

BACKGROUND:

Since the early 1960's the doves, rail and quail of Guam have received the most attention by biologists of the Division of Aquatic and Wildlife Resources. These were the huntable species on Guam at that time and the bulk of the roadside counts, hunter censuses, banding, food habits, and nesting studies were concentrated on these birds. Because of increasingly low population levels of almost all the birds of Guam, the only game bird which is legally hunted currently is the introduced Philippine turtle dove (*Streptopelia bitorquata*). The hunting season on this dove is currently one month (July) with a season limit of 10 birds.

Much of the decline of the native avifauna has probably been caused by excessive pesticide spraying, increased urbanization of Guam and the resultant clearing of much of the native vegetation, and the effects of introduced predators. Many of the native bird species are now restricted to the remaining areas of natural vegetation that primarily occur along the northern cliffline in a thin strip from NCS Beach through Catalina Point on the eastern side of Guam. This area is literally the last refuge for many of the native birds of Guam. The ravine forests of southern Guam are nearly devoid of birdlife.

Since little is known of the life histories or ecology of these species, it is imperative that the Division of Aquatic and Wildlife Resources take the initiative in studying and protecting these birds. Toward that goal several ecological studies have been started on the native birds of Guam. Census data have been evaluated on these birds and ten native bird species have been proposed for listing under the Federal Endangered Species Act of 1973 (Appendix 1). Such a listing allows for determination of critical habitat and the protection of this habitat under federal law.

OBJECTIVES:

I. To determine and monitor the status of the land birds of Guam.

II. To determine the population sizes and seasonal habits of the shorebirds and seabirds of Guam.

III. To census natural habitats for population estimates of the rare bird species on Guam.

IV. To compile field notes on habitat utilization of rare birds whenever they are encountered.

PROCEDURES:

I. Roadside Counts:

Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1). Roadside counts have been conducted on routes of 12 and 25 miles in Northwest Field and northern Guam, respectively, since 1974. In 1976 a new route of 14 miles was established through the north-central portion of the island. These routes were driven at approximately 10-15 miles per hour, beginning at sunrise. Numbers and species of all birds seen were recorded.

II. Shorebird Survey:

Shorebird survey transects were established along the shoreline of Agana Bay on the western side of Guam and along Togcha Beach on the eastern side (Figure 2). These transects were surveyed weekly for one year, with the numbers and species of all shorebirds (Families Charadriidae and Scolopacidae) observed being recorded.

III. Forest Bird Station-Count Census:

Nine census stations (points) were established in northern cliffline areas and two census stations were established in forested areas on the northern plateau of Guam (Figure 2). These census stations

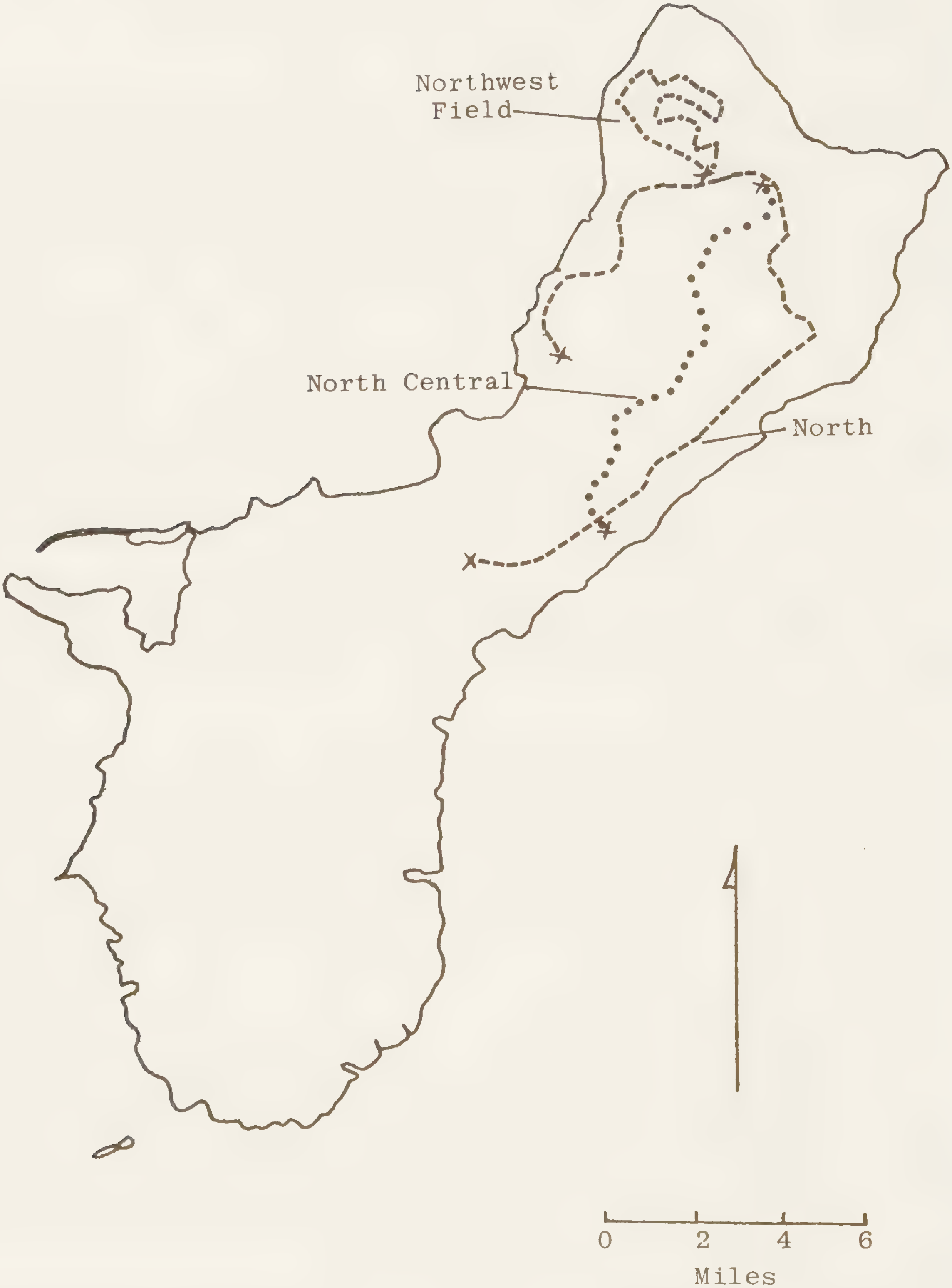

Northwest Field
North Central
North
0
2
4
6
Miles

Figure 1. North, North-Central, and Northwest Field Roadside Bird Census Routes.

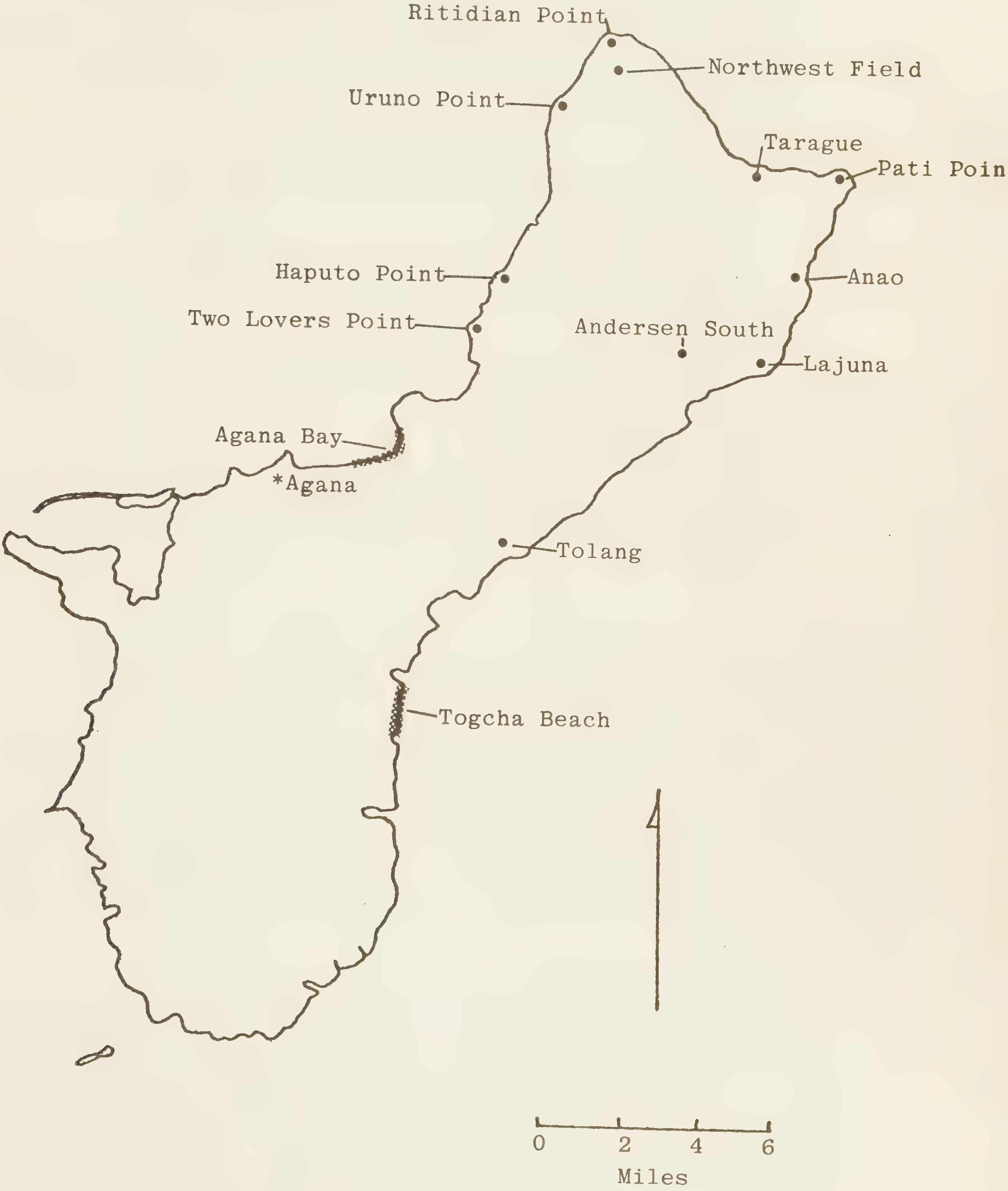

Ritidian Point
Northwest Field
Uruno Point
Tarague
Pati Poin
Haputo Point
Anao
Two Lovers Point
Andersen South
Lajuna
Agana Bay
*Agana
Tolang
Togcha Beach
0
2
4
6
Miles

Figure 2. Shorebird transect and native forest bird point-count census locations.

were visited at weekly intervals within three hours after sunrise. Each individual bird species heard or seen was counted and an estimate made of the distance the bird was from the observer. Each census period was 15 minutes, with the first 8 minute segment being recorded separately. Following Shallenberger (1978), these data were used to generate three indices of species abundances for each census station:

> Species Frequency - Number of count periods during which a species was recorded, divided by the total number of count periods.
>
> Species Incidence - Number of birds of a species recorded, divided by the number of count periods during which the species was recorded.
>
> Relative Abundance - The number of birds of a species recorded, divided by the number of the most abundant species recorded during the same count periods.

IV. Ecological Observations:

A major effort was made to locate native birds and to make ecological and behavioral observations. Extensive field notes were made on the ecology, life history and habitat utilization of those birds observed.

FINDINGS:

Data from the roadside counts conducted during 1978 and the first nine months of 1979 are presented in Tables 1-6, expressed as the number of birds of each species observed per 100 miles of travel each month. In order to illustrate population changes and trends over the past years, roadside count data for selected species collected since 1974 were compiled and are presented in Tables 7-15. These tables present the mean number of birds seen per 100 miles of travel as well as the standard deviation and coefficient of variation. The Mann-Whitney U-Test (Sokal and Rohlf 1969) was used to test for significant differences between the means of successive years ($P<.05$); those years which differ significantly from the preceeding year are indicated by an asterisk. Examination of these tables reveals the following trends:

Marianas Crow (Table 7):

This species, formerly distributed island-wide, is now most commonly observed in the cliffline areas of northern Guam. This is strikingly evident in Table 7 which shows roadside count means five to six times higher in Northwest Field than in the other roadside counts areas. The count data for Northwest Field indicate that crow populations have been fairly stable in this area since 1974, with mean counts ranging between 23 and 36 birds per 100 miles of travel. The counts in the other two areas document a slow but statistically non-significant

Table 1. Number of birds per 100 miles of travel observed each month on the North roadside count route during 1978.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	$\bar{X}$/Count	$\bar{X}$/100 mi
Bittern	5.9	2.0	2.0	0	4.1	0	0	14.0	8.1	17.4	8.1	14.4	43	1.6	6.7
Marianas Crow	0	0	4.1	0	0	0	0	0	2.0	0	2.0	0	4	0.1	0.6
Drongo	78.4	39.8	97.8	38.7	53.9	82.3	69.4	83.8	101.6	144.8	82.8	47.4	505	19.4	78.4
Fantail	2.0	4.0	4.1	0	1.4	0	0	0	0	0	2.0	0	7	0.3	1.1
Fruit Dove	0	0	0	0	0	0	0	0	2.0	0	0	0	1	0.04	0.1
Golden Plover	25.5	27.8	12.2	27.1	9.7	0	0	0	79.3	139.4	66.7	51.5	255	9.8	39.6
Ground Dove	2.0	2.0	14.2	1.9	8.3	2.1	4.1	4.0	8.1	8.0	2.0	6.2	35	1.3	5.4
Honeyeater	3.9	0	0	0	0	4.1	0	0	2.0	0	0	0	5	0.2	0.7
Kingfisher	0	6.0	2.0	0	0	0	0	2.0	0	12.1	0	0	14	0.5	2.2
Noddy Tern	0	15.9	0	0	0	0	0	0	0	0	0	0	8	0.3	1.2
P. T. Dove	9.8	47.7	14.3	15.5	20.7	22.6	20.4	49.9	77.2	42.9	28.3	45.4	211	8.1	32.8
Quail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	3.9	8.0	8.1	5.8	10.9	12.3	2.0	6.0	16.3	4.0	2.0	10.3	48	1.8	7.4
Rice Bird	88.2	0	0	21.3	26.3	0	55.1	59.9	61.0	8.0	20.2	0	178	6.8	27.6
Sparrow	5.9	2	0	15.5	24.9	20.6	20.4	35.9	52.8	55	16.2	82.5	183	7.0	28.4
Starling	23.5	6.0	0	0	4.1	12.3	6.1	12.0	18.3	12.1	10.1	4.1	58	2.2	9.0
White Tern	5.9	0	42.8	3.9	9.7	0	2.0	4.0	6.1	4.0	0	6.2	45	1.7	7.0
Miles	51.0	50.3	49.1	51.7	72.3	48.6	49.0	50.1	49.2	74.6	49.5	48.5	643.9	24.76	
Counts	2	2	2	2	3	2	2	2	2	2	2	2	26		

Table 2. Number of birds per 100 miles of travel observed each month on the North roadside count route during the first nine months of 1979.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total	$\overline{X}$/Count	$\overline{X}$/100 mi
Bittern	10.6	8.5	0	2.1	6.8	15.6	1.9	1.9	27.8	39	2.1	8.3
Marianas Crow	0	0	0	0	0	0	0	0	2.0	1	0.1	0.2
Drongo	35.9	46.5	66.8	56.8	66.7	78.0	41.3	35.1	63.6	260	13.7	55.2
Fantail	6.3	8.5	6.1	0	2.7	1.9	0	0	0	13	0.7	2.8
Fruit Dove	0	0	0	0	1.4	0	0	0	0	1	0.1	0.2
Golden Plover	63.4	46.5	52.6	92.6	6.8	0	0	0	19.9	137	7.2	29.1
Ground Dove	4.2	6.3	2.0	6.3	2.7	3.9	5.6	3.9	2.0	19	1	4.0
Honeyeater	0	0	0	2.1	1.4	5.8	0	0	0	5	0.3	1.1
Kingfisher	2.1	0	2.0	2.1	4.1	0	0	0	2.0	7	0.4	1.5
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	0
P. T. Dove	14.8	27.5	14.2	25.3	17.7	15.6	18.8	19.5	43.7	102	5.4	21.6
Quail	0	0	0	0	28.6	0	3.8	1.9	0	24	1.3	5.1
Rail	2.1	19.0	8.1	4.2	8.2	7.8	3.8	11.7	2.0	35	1.8	7.4
Rice Bird	21.1	0	87	21.1	17.7	27.3	16.9	0	0	99	5.2	21.0
Sparrow	0	6.3	0	31.6	5.4	23.4	30.0	46.8	6.0	77	4.1	16.3
Starling	8.5	8.5	6.1	4.2	12.2	15.6	1.9	9.7	8.0	40	4.1	16.3
White Tern	0	19.0	4.0	12.6	4.1	3.9	0	7.8	0	26	1.4	5.5
Miles	47.3	47.3	49.4	47.5	73.5	51.3	53.3	51.3	50.3	471.2	24.8	
Counts	2	2	2	2	2	2	2	2	2	19		

Table 3. Number of birds per 100 miles of travel observed each month on the Northwest Field roadside count route during 1978.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	$\overline{X}$/Count	$\overline{X}$/100 mi
Bittern	11.2	8.4	21.1	16.8	41.4	12.6	0	8.4	20.9	8.3	4.2	8.5	44	1.8	14.8
Marianas Crow	16.8	0	8.4	50.0	8.3	46.2	42.0	101.3	41.8	16.6	20.9	25.5	93	3.7	31.2
Drongo	521	428.5	658.2	680.7	751.4	777.3	852.9	557.0	301.3	377.6	71.1	89.4	1,548	61.9	519.5
Fantail	19.6	0	0	21	22.1	12.6	0	54.9	41.8	24.9	33.5	17.0	64	2.6	21.5
Fruit Dove	0	0	0	8.4	0	12.6	8.4	4.2	4.2	0	0	0	.9	0.4	3.0
Golden Plover	53.2	25.2	29.5	8.4	0	54.6	0	12.7	75.3	132.8	125.5	59.6	141	5.6	47.3
Ground Dove	16.8	8.4	4.2	4.2	24.9	12.6	8.4	16.9	0	0	0	0	27	1.1	9.1
Honeyeater	64.4	75.6	46.4	63.2	47.0	12.6	21	29.5	16.7	41.5	29.3	12.8	114	4.6	38.3
Kingfisher	11.2	8.4	29.5	21	30.4	12.6	8.4	16.9	8.4	20.7	12.6	8.5	49	2.0	16.4
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. T. Dove	36.4	16.8	54.9	75.6	140.9	214.3	134.5	151.9	221.8	99.6	150.6	51.1	341	13.6	114.4
Quail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	4.2	0	0	8.4	8.4	0	0	8.3	0	21.3	12	0.5	4.0
Rice Bird	187.7	0	21.1	126.1	248.6	0	0	67.5	92.1	0	83.7	34.0	258	10.3	86.6
Sparrow	0	0	0	0	0	8.4	0	0	0	0	0	0	2	0.1	0.7
Starling	196.1	142.9	211.0	147.1	127.1	180.7	163.8	147.7	129.7	170.1	108.8	59.6	447	17.9	150.0
White Tern	36.4	0	25.3	25.2	38.7	63.0	0	0	0	0	0	29.8	61	2.4	20.5
Miles	35.7	11.9	23.7	23.8	36.2	23.8	23.8	23.7	23.9	24.1	23.9	23.5	298.0	11.9	
Counts	3	1	2	2	3	2	2	2	2	2	2	2	25		

Table 4. Number of birds per 100 miles of travel observed each month on the Northwest Field roadside count route during the first nine months of 1979.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total	$\overline{X}$/Count	$\overline{X}$/100 mi
Bittern	4.1	28.9	8.2	11.2	16.2	17.0	4.2	17.4	17.0	41	2.2	18.0
Marianas Crow	8.3	20.7	16.4	5.6	20.3	29.8	50.2	100	72.3	77	4.0	33.9
Drongo	95.0	132.2	225.4	486.0	837.4	234.0	330.5	217.4	297.9	744	39.2	327.6
Fantail	4.1	8.3	8.2	11.2	36.6	8.5	12.6	26.1	4.3	30	1.6	13.2
Fruit Dove	0	0	0	0	0	0	12.6	0	8.5	5	0.3	2.2
Golden Plover	78.5	70.2	36.9	14.0	0	0	0	169.6	17.0	93	4.9	40.9
Ground Dove	0	0	8.2	2.8	12.2	8.5	0	4.3	4.3	10	0.5	4.4
Honeyeater	4.1	16.5	8.2	11.2	40.7	8.5	12.6	13	17.0	33	1.7	14.5
Kingfisher	4.1	4.1	4.1	11.2	12.2	4.3	16.7	13	8.5	20	1.0	8.8
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	0
P. T. Dove	124	128.1	114.8	111.7	235.8	302.1	255.2	252.2	238.3	433	22.8	190.7
Quail	0	0	0	0	0	0	0	0	0	0	0	0
Rail	4.1	8.3	12.3	2.8	24.4	0	4.2	8.7	8.5	18	0.9	7.9
Rice Bird	41.3	24.8	0	5.6	8.1	0	0	0	25.5	26	1.4	11.4
Sparrow	0	0	0	0	0	12.8	0	0	12.8	6	0.3	2.6
Starling	86.8	165.3	86.1	108.9	174.8	93.6	125.5	230.4	212.8	319	16.8	140.5
White Tern	4.1	8.3	0	0	4.1	0	8.4	0	0	6	0.3	2.6
Miles	24.2	24.2	24.4	35.8	24.6	23.5	23.9	23.0	23.5	227.1	12.0	
Counts	2	2	2	3	2	2	2	2	2	19		

Table 5. **Number of birds per 100 miles of travel observed each month on the North Central roadside count route during 1978.**

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	$\overline{X}$/Count	$\overline{X}$/100 mi
Bittern	13.7	19.7	16.8	16.7	9.2	17.2	24.2	27.1	36.9	42.5	26.1	16.6	84	3.4	22.7
Marianas Crow	0	0	0	3.3	0	0	0	0	0	0	0	0	3	0.1	0.8
Drongo	301.4	259.7	281.9	283.3	160.6	131.0	186.9	176.3	117.4	134.2	127.5	115.9	680	27.2	183.4
Fantail	0	0	3.4	10	0	0	0	0	6.7	0	0	3.3	7	0.3	1.9
Fruit Dove	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Golden Plover	630.1	1051.9	828.9	906.7	224.8	0	0	0	379.2	1105.1	585	334.4	1,868	74.7	503.9
Ground Dove	30.8	45.5	33.6	40	41.3	0	24.2	16.9	36.9	29.1	9.8	0	95	3.8	25.6
Honeyeater	10.3	0	0	0	0	3.4	0	0	0	0	0	3.3	5	0.2	1.3
Kingfisher	0	0	16.8	6.7	9.2	17.2	6.9	3.4	3.4	6.7	0	23.2	30	1.2	8.1
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	3.3	1	(0.04)	0.3
P. T. Dove	119.9	90.9	181.2	86.7	178.9	206.9	204.2	108.5	187.9	111.9	98	102.6	525	21.0	141.6
Quail	6.8	0	0	0	6.9	0	0	0	0	0	0	0	5	0.2	1.3
Rail	140.4	58.4	80.5	80	66.5	44.8	10.4	108.5	63.8	58.2	32.7	59.6	248	9.9	66.9
Rice Bird	113.0	0	194.6	33.3	123.9	96.6	13.8	210.2	80.5	152.1	22.9	6.6	350	14.0	94.4
Sparrow	0	39.0	80.5	16.7	29.8	37.9	38.1	16.9	23.5	13.4	32.7	13.2	102	4.1	27.5
Starling	17.1	13.0	10.1	10	6.9	24.1	10.4	10.2	0	8.9	16.3	6.6	40	1.6	10.8
White Tern	24.0	6.5	26.8	53.3	36.7	10.3	10.4	0	20.1	158.8	32.7	19.9	147	5.9	39.6
Miles	29.2	15.4	29.8	30.0	43.6	29.0	29.8	29.5	29.8	44.7	30.6	30.2	370.7	14.8	
Counts	2	1	2	2	3	2	2	2	2	3	2	2	25		

Table 6. Number of birds per 100 miles of travel observed each month on the North Central roadside count route during the first nine months of 1979.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total	$\overline{X}$/Count	$\overline{X}$/100 mi
Bittern	17.3	17.7	10.2	32.3	2.3	10.5	13.7	17.1	22.4	40	2.1	14.9
Marianas Crow	0	0	0	0	0	0	0	0	0	0	0	0
Drongo	103.8	297.9	88.1	114.7	93.6	157.3	130.6	119.5	139.0	362	19.1	135.3
Fantail	17.3	17.7	3.4	28.7	0	0	0	6.8	0	21	1.1	7.8
Fruit Dove	0	14.2	3.4	0	2.3	7.0	0	0	0	8	0.4	3.0
Golden Plover	799.3	1262.4	444.1	186.4	0	0	10.3	0	910.3	976	51.4	364.7
Ground Dove	0	31.9	13.6	7.2	13.7	17.5	6.9	13.7	0	32	1.7	12.0
Honeyeater	0	0	3.4	0	0	0	6.9	0	0	3	0.2	1.1
Kingfisher	3.5	10.6	0	7.2	0	7.0	3.4	10.2	0	12	0.6	4.5
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	0
P. T. Dove	114.2	159.6	67.8	93.2	89.0	143.4	116.8	119.5	148	306	16.1	114.3
Quail	0	24.8	0	32.3	105.0	140.0	0	54.6	0	118	6.2	44.1
Rail	17.3	24.8	16.9	32.3	13.7	35.0	24.1	37.5	17.9	64	3.4	23.9
Rice Bird	45.0	31.9	139.0	107.5	157.5	150.3	58.4	116.0	89.7	276	14.5	103.1
Sparrow	0	14.2	33.9	28.7	38.8	42.0	34.4	0	94.2	82	4.3	30.6
Starling	3.5	0	16.9	39.4	13.7	17.5	17.2	20.5	0	39	2.1	14.6
White Tern	0	3.5	23.7	0	11.4	38.5	0	0	0	24	1.3	9.0
Egret	72.7	0	30.5	60.9	4.6	0	0	0	0	49	2.6	18.3
Miles	28.9	28.2	29.5	27.9	43.8	28.6	29.1	29.3	22.3	267.6	14.1	
Counts	2	2	2	2	3	2	2	2	2	19		

decline from highs of approximately 2 birds per 100 miles of travel. Crow occurrence in areas other than Northwest Field and the northern cliffline area now appears to be accidental in nature.

Fantail (Table 8):

Northwest Field appears to have the highest fantail population of the three areas censused by roadside count. Fantail populations in this area appear to have increased significantly between 1974 and 1976, when the mean number of birds per 100 miles of travel peaked at 36. The counts then began a steady decline to the present (13 birds per 100 miles of travel), though no significant differences are shown between successive years.

Both the North and North-Central routes appear to have declined since 1976, with significant changes taking place in 1977 on the North route and in both 1977 and 1978 on the North Central. The decline on the North-Central route is particularly dramatic as the mean number of birds per 100 miles of travel dropped from 30.5 in 1976 to approximately 2 in 1978.

Fruit Dove (Table 9):

Fruit dove populations have been consistently highest on the Northwest Field route since 1974. There was a significant drop from a mean of 13.1 in 1975 to 6.8 birds per 100 miles of travel in 1976. The 1977 mean count was 12.3 birds per 100 miles of travel, but this dropped significantly to 3.2 in 1978, the lowest since the roadside counts began in this area in 1974. The data for the first nine months of 1979 indicates that the population is still low.

Both the North and North-Central roadside count routes have had very low mean fruit dove counts since the beginning, with no birds being observed at all on the North route in 1977 and the North-Central route in 1978.

Ground Dove (Table 10):

Ground dove numbers seem to have fluctuated most greatly in the Northwest Field area with mean numbers of birds per 100 miles of travel increasing from 9.9 in 1974 to 34.5 in 1977, and then dropping significantly to 8 in 1978. The data for the first nine months of 1979 indicates a possible further decline of this species in the Northwest field area.

Populations in the areas censused by the North and North-Central roadside counts have been subject to much less fluctuation. The North route exhibited a significant increase in mean number of ground doves per 100 miles of travel in 1975 and peaked in 1976 with a mean count of 8.7. Counts on this route have since declined to 5.2 in 1978 and 4.1 during the first 9 months of 1979. The North Central route remained remarkably stable between 1976 and 1978 (21-25.7 birds per 100 miles

Table 7. Results of roadside counts conducted over three routes since 1974. showing the mean number of Marianas crow seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\overline{X}$	1.7	1.0	1.7	1.6	.7	.2
	σ	1.9	1.6	3.8	2.5	1.3	.7
	CV	112.1	161.5	215.5	160.9	197.0	303.2
NORTHWEST FIELD	$\overline{X}$	23.0	31.5	24.6	32.1	31.5	36.0
	σ	10.0	22.5	32.8	22.8	27.5	32.0
	CV	43.1	71.5	133.6	70.9	87.2	89.1
NORTH CENTRAL	$\overline{X}$			.7	2.2	.8	-0-
	σ			1.9	3.0	2.1	-0-
	CV			265.7	137.9	248.5	-0-

Table 8. Results of roadside counts conducted over three routes since 1974, showing the mean number of fantails seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding years as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\overline{X}$	.8	9.2	9.3	3.3*	1.1	2.8
	σ	1.9	13.1	6.3	3.1	1.6	3.3
	CV	246.2	142.4	67.6	92.5	139.8	117.0
NORTHWEST FIELD	$\overline{X}$	.3	15.1	36.0*	23.2	20.6	13.3
	σ	.8	24.2	19.9	18.2	17.0	10.9
	CV	248.5	161.1	55.3	78.3	82.3	81.8
NORTH CENTRAL	$\overline{X}$			30.5	11.5*	2.0*	8.2
	σ			15.6	5.3	3.3	10.5
	CV			51.6	45.8	170.8	128.3

Table 9. Results of roadside counts conducted over three routes since 1974, showing the mean number of fruit doves seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\bar{X}$	1.4	1.1	1.0	-0-	.2	.2
	σ	1.4	1.6	2.5	-0-	.6	.5
	CV	96.5	146.7	247.5	-0-	345.5	299.4
NORTHWEST FIELD	$\bar{X}$	7.1	13.1	6.5*	12.3	3.2*	2.3
	σ	3.9	7.3	5.3	10.6	4.4	4.8
	CV	55.1	55.7	81.9	86.6	140.6	203.4
NORTH CENTRAL	$\bar{X}$			.8	.6	-0-	3.0
	σ			1.5	2.0	-0-	4.8
	CV			173.8	346.1	-0-	161.9

Table 10. Results of roadside counts conducted over three routes since 1974, showing the mean number of Ground Doves seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\bar{X}$	3.4	6.9*	8.7	4.8	5.2	4.1
	σ	.8	4.1	4.8	4.5	3.8	1.7
	CV	22.5	58.4	54.9	93.8	73.1	41.2
NORTHWEST FIELD	$\bar{X}$	9.9	25.0	24.7	34.5	8.0*	4.5
	σ	5.5	16.5	13.0	27.7	8.3	4.4
	CV	55.5	66.7	52.7	80.2	102.7	97.8
NORTH CENTRAL	$\bar{X}$			21.1	22.6	25.7	11.6
	σ			11.2	15.0	15.7	9.8
	CV			53.2	66.5	61.2	84.4

of travel) but has exhibited a marked, though non-significant drop to 11.6 during the first nine months of 1979.

Honeyeater (Table 11):

Northwest Field appears to have consistently had the highest population of honeyeaters of the three areas censused by roadside count. Honeyeater counts in Northwest Field climbed gradually from 1974 until 1977 when they peaked at 50.4 birds per 100 miles of travel. Counts have since declined, with a significant drop during the first nine months of 1979, to 14.6 birds per 100 miles of travel. The North route exhibited a significant increase to 16.5 birds per 100 miles of travel in 1975, followed by a significant drop to 7.5 in 1976. The counts on this route have declined steadily since then. Roadside counts of honeyeaters show a similar pattern on the North Central route, dropping significantly from a high of 26.9 birds per 100 miles to travel in 1976 to 5.9 in 1977, with a further steady decline to the present.

Kingfisher (Table 12):

Roadside counts of kingfishers have been consistently higher in Northwest Field than on the other two census routes. Though no significant differences between successive years were indicated by the Mann-Whitney U-Tests, the mean number of birds per 100 miles of travel appears to have increased steadily to a high of 17.0 in 1977, followed by a decline to 8.7 during the first nine months of 1979.

The area censused by the North-Central route has exhibited the next highest population levels of kingfishers. Mean counts in this area have gradually dropped from a high of 12 birds per 100 miles of travel in 1977 to 4.6 in the first 9 months of 1979. The North route has exhibited the lowest population levels, declining from a high of 3.7 birds per 100 miles of travel in 1975 to a low of 1.4 in the first nine months of 1979.

Philippine Turtle Dove (Table 13):

The Northwest Field area appears to have the highest current populations of P. T. doves of the three areas censused by roadside count. The number of birds observed per 100 miles of travel declined significantly from 146 in 1974 to 55.9 in 1976, but increased significantly in 1977 and has continued to climb to 195.9 during the first nine months of 1979.

The North Central route had a mean count of 278.3 doves per 100 miles of travel in 1976, the highest recorded on any route. This dropped significantly in 177 and has continued to decline to 116.9 in the first nine months of 1979. Population levels on the North route have been consistenly lower than the other two, gradually increasing to a high of 34.1 birds per 100 miles of travel in 1977 and then dropping to 21.9 during the first nine months of 1979.

Guam Rail (Table 14):

The area censused by the North Central roadside count route has con-

Table 11. Results of roadside counts conducted over three routes since 1974, showing the mean number of honeyeaters seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate mean significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\bar{X}$	5.7	16.5*	7.5*	2.3	.8	1.0
	σ	7.0	5.8	5.2	3.3	1.6	2.0
	CV	125.1	35.0	68.2	145.1	191.6	189.3
NORTHWEST FIELD	$\bar{X}$	13.9	43.2	49.4	50.4	38.3	14.6*
	σ	17.3	30.2	17.4	24.6	21.5	10.6
	CV	124.9	69.9	35.2	48.9	56.0	72.3
NORTH CENTRAL	$\bar{X}$			26.9	5.9*	1.4	1.1
	σ			18.3	7.9	3.1	2.4
	CV			68.0	132.0	216.9	213.2

Table 12. Results of roadside counts conducted over three routes since 1974, showing the mean number of kingfishers seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\bar{X}$	.7	3.7*	2.5	1.8	1.8	1.4
	σ	.8	3.2	3.0	2.4	3.7	1.5
	CV	119.4	85.7	119.8	134.3	200.5	105.8
NORTHWEST FIELD	$\bar{X}$	8.1	10.8	11.8	17.0	15.7	8.7
	σ	3.9	6.7	9.7	11.2	8.1	4.8
	CV	48.3	61.6	82.2	65.5	51.2	55.1
NORTH CENTRAL	$\bar{X}$			11.5	12.2	7.8	4.7
	σ			8.7	13.7	7.6	4.3
	CV			75.7	112.7	97.4	91.6

Table 13. Results of roadside counts conducted over three routes since 1974, showing the mean number of Philippine turtle doves seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate mean significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\bar{X}$	23.5	27.3	30.3	34.1	32.9	21.9
	σ	7.3	7.7	17.1	21.8	19.9	9.4
	CV	30.9	28.1	56.5	64.1	60.4	42.7
NORTHWEST FIELD	$\bar{X}$	145.5	95.0	55.9*	103.0*	112.4	195.8
	σ	66.6	39.0	23.5	57.3	67.5	74.8
	CV	45.8	41.0	42.0	55.7	60.1	38.2
NORTH CENTRAL	$\bar{X}$			278.3	183.7*	139.8	116.8
	σ			97.3	67.6	47.4	30.1
	CV			35.0	36.8	33.9	25.8

Table 14. Results of roadside counts conducted over three routes since 1974, showing the mean number of rails seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\bar{X}$	15.1	19.3	18.1	15.0	7.5	7.4
	σ	9.5	11.2	12.8	16.4	4.4	5.4
	CV	62.9	57.8	71.0	109.6	58.6	73.0
NORTHWEST FIELD	$\bar{X}$	21.1	17.9	6.4*	3.7	4.2	8.1*
	σ	15.4	11.3	3.8	5.5	6.5	7.2
	CV	73.0	64.2	59.1	142.6	154.5	87.8
NORTH CENTRAL	$\bar{X}$			129.4	55.9*	67.0	24.4*
	σ			43.3	70.2	33.8	8.7
	CV			33.4	125.6	50.4	35.7

sistently had the highest apparent rail population though it appears to be declining rapidly. The route had a mean count of 129.4 birds per 100 miles of travel in 1976 and exhibited a significant decline to 55.9 in 1977 and to 24.4 during the first nine months of 1979. This precipitous drop is of great concern because the North Central route was intentionally selected in 1976 to census the remaining preferred habitats of rails on the northern plateau.

Rail numbers in Northwest Field and along the North route are much lower. The mean number of birds per 100 miles of travel in Northwest Field declined significantly from 17.9 in 1975 to 6.4 in 1976. This downward trend continued through 1978. Preliminary indications from data collected during the first nine months of 1979 are that rail numbers in Northwest Field may now be increasing, as the mean number of birds per 100 miles increased significantly from 4.2 in 1978 to 8.1 in 1979. Rail counts along the North route reached a high of 19.3 birds per 100 miles in 1975 but have declined ever since, to 7.4 in the first nine months of 1979.

Starling (Table 15):

Roadside counts of starlings in the Northwest Field area have been more or less stable for several years. The mean number of birds per 100 miles of travel reached a high of 193.4 in 1975 and a low of 129.5 the following year. That decline was not statistically significant, however, and the counts since then have not dropped below the 142.7 recorded during the first nine months of 1979.

Counts of starlings on the other two routes have declined in recent years. The North Central route had a high of 57.2 birds per 100 miles of travel in 1976 but only 11.1 in 1978. On the North route, starling counts increased significantly in 1975 to a mean of 33.2 birds per 100 miles of travel, but dropped significantly the next year to 14.5. There has been a continued decline to the present.

Examination of Tables 7-15 reveals that the roadside count data is highly variable, with an average coefficient of variation of 100. This extreme variability of the data explains why statistically significant differences between successive years roadside counts were so seldom shown in the Mann-Whitney U-Test analysis of these data. In some cases the mean number of birds per 100 miles of travel would change by a factor of 3 or more, with no significant difference being indicated.

In an attempt to evaluate the sensitivity of roadside counts to population changes, coefficients of variation (CV) were computed for each species by year, and these figures averaged to give a mean statistic ($\overline{CV}$) for each of the species listed in Tables 7-15. The percentage change in true mean (δ) detectable ($P>.80$) using roadside counts at three sampling intensities (12, 24, and 48 counts per year) was then estimated using the following formula derived by Wheeler (1979):

$$\text{Percent change in mean that can be detected} = \delta = \overline{CV} \; \frac{2\{t_{.05\{\nu\}} + t_{2(.2)\{\nu\}}\}^2}{n}$$

Table 15. Results of roadside counts conducted over three routes since 1974, showing the mean number of starlings seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

YEAR		74	75	76	77	78	79 (9 MOS)
NORTH	$\bar{X}$	13.6	33.2*	14.5*	12.9	9.1	8.3
	σ	8.8	8.9	11.8	7.3	7.1	4.0
	CV	64.8	26.7	81.3	56.5	78.5	48.5
NORTHWEST FIELD	$\bar{X}$	179.4	193.4	129.5	156.9	148.7	142.7
	σ	68.9	85.5	53.6	42.6	40.7	55.2
	CV	38.4	44.2	41.3	27.1	27.4	38.7
NORTH CENTRAL	$\bar{X}$			57.3	37.6	11.3	12.3
	σ			24.1	40.4	6.1	86.4
	CV			42.2	107.3	54.5	4.7

The results of this analysis are shown in Table 16. It is obvious from this analysis that roadside counts are not a sensitive measure of population changes, though over the long run they do reflect changes in bird abundance. Even doubling the sampling intensities, from twice (N=24) to four times per month (N=48), would be insufficient to detect anything but major changes (δ>.25) in populations of most species. It is hoped that the station or point count census technique now being used to census native forest birds will prove to be a more sensitive indication of population changes.

Shorebird Surveys

A year-long shorebird (Families: Charadriidae, Scolopacidae) survey was completed during this report period, which included 100 weekly counts at two locations on Guam. A total of 21 species were recorded which fell into three groups of migrants: common regular migrants (6), uncommon regular migrants (4), and casual migrants (11). Casual migrants included four new records of migratory shorebirds previously unreported from Guam. The findings of these surveys have been included in a manuscript entitled "Seasonality and relative abundance of Guam shorebirds" (Jenkins, 1980 (b)), and for this reason shall not be discussed further here.

New shorebird records plus several new accidental bird records were included in a revised Checklist of Guam Birds, completed during this project segment. The revised checklist is presented in Appendix 2.

Seabird Surveys

On 7 March, 1979, a boat survey was conducted along Orote Pennisula and south to Facpi Point. A total of 258 common noddy terns (*Anous stolidus*) were observed, all in adult plumage. Several nests were observed among the larger nesting colonies. Colonies were found in identical locations as last year's survey: 52 birds on a small islet off the pennisula, 56 adults on Neye Island, and the largest colony of 120 adults on a small islet adjacent to Anae Island. A small colony of 25 birds was observed on Orote Island. No juveniles were observed on this survey.

In April, 1979, another survey of breeding common noddy terns was conducted in the same location. This count reached 343 birds, some of which appeared in juvenile plumage. Spring appears to be an important breeding season for noddy terns on Guam, although juveniles have been observed year-round, and this probably indicates year-round breeding.

Native Birds

Due to severely depleted populations with restricted ranges, ten of the native birds of Guam have been proposed for listing on the U. S. Endangered Species List; action on these proposals is pending at this time. These include two endemic species (*Rallus owstoni*, *Myiagra freycineti*), two endemic subspecies (*Halycon c. cinnamomia*, *Zosterops c. conspicillata*), and six species which occur on more than one island of the Marianas Archipelago (*Gallinula chloropus guami*, *Gallicolumba x. xanthonura*, *Ptilinopus roseicapillus*, *Collocalia vanikorensis bartschi*, *Corvus kubaryi*, *Myzomela cardinalis saffordi*). Proposals to list the Guam populations of these species are presented in Appendix 2. In addition, a survey of the six species occuring on other Mariana Islands detailing the results of these surveys has been prepared

Table. 16 Percentage change (δ) in true mean of roadside counts of selected bird species that can be detected ($P=.8$) at various sampling intensities (N).

	SAMPLING INTENSITY	BLACK CROW	FANTAIL	FRUIT DOVE	GROUND DOVE	HONEY-EATER	KING-FISHER	P.T. DOVE	RAIL	STARLING
NORTH	12	240.8	168.6	237.2	72.0	157.9	160.2	59.2	90.6	74.6
	24	162.0	113.4	159.9	48.4	106.2	107.8	39.8	60.9	50.2
	48	112.0	78.4	110.5	33.5	73.4	74.5	27.5	42.1	34.7
NORTHWEST FIELD	12	103.7	148.0	130.5	95.3	85.2	76.7	59.2	124.2	45.5
	24	69.8	99.6	87.8	64.1	57.4	51.3	39.8	81.9	30.6
	48	48.2	68.8	60.7	44.3	39.6	35.4	27.5	56.6	21.1
NORTH CENTRAL	12	204.8	124.5	214.1	83.3	197.8	118.5	41.3	77.0	91.2
	24	137.8	83.8	144.0	56.1	133.1	79.7	27.8	51.8	61.3
	48	95.2	57.9	99.5	38.7	92.0	55.1	19.2	35.7	42.4

for publication (Jenkins and Aguon, 1980).

A study summarizing nearly twenty years of roadside counts and field notes on the "Natural history of the Guam Rail" was completed during this project segment (Jenkins, 1980 (a)). This flightless endemic bird has suffered severe population declines over the past decade, and a program of conservation and management is vitally necessary for its survival.

Extensive field notes have been compiled during this project segment on the life history, ecology, and behavior of the native forest birds of Guam. During the next project segment these notes will be used to produce a manuscript detailing the known natural history characteristics of the native forest birds of Guam.

A year-long survey using station counts around the northern cliffline of Guam has been completed. A summary of the data appears in Tables 17 through 19.

Although these data require a computerized analysis to be continued in the next project segment, several trends are apparent from an initial inspection of the data. Native birds are rare along the northeastern cliffline points of Tolang, Lajuna, and Anao. Virtually missing from the eastern cliffline are the Micronesian broadbill, rufous-fronted fantail, Marianas fruit dove, cardinal honeyeater and the bridled white-eye. Four native species showed a greater distribution around the northern cliffline: Marianas crow, white-throated ground dove, Micronesian kingfisher, and Micronesian starling. Species showing overall low frequencies included the broadbill, ground dove, honeyeater, and white-eye. The starling, kingfisher, fantail and crow had relatively higher overall species frequencies; yet their distributions remain restricted to the northern cliffline of Guam. Generally, the northern and northwestern cliffline of Guam still supports populations of most of the native birds, and represents the best forest bird habitat remaining on Guam.

RECOMMENDATIONS:

I. Breakdown the present Job (W-13) into separate jobs dealing with shorebirds, seabirds, native birds, endangered species, and game birds.

II. Continue bi-monthly roadside counts on three routes over northern and central Guam.

III. Continue monthly shorebird surveys at two locations on Guam.

IV. Continue annual surveys of breeding common noddy terns.

V. Continue station counts of native birds in the northern cliffline, but reduce counts to once a month after a year-long baseline has been acheived.

VI. Complete manuscript on the life history, ecology, and behavior of the native land birds of Guam.

Table 17. Species frequencies of 11 forest birds of Guam recorded on weekly counts at 12 sites from October 1978 to October, 1979. Names indicate cliffline points except Andersen South and Northwest Field.

	TOLANG	ANDERSEN SOUTH	LAJUNA	ANAO	PATI	TARAGUE	NORTH-WEST FIELD	RITIDIAN	URUNO	HAPUTO	TWO LOVERS POINT	TOTAL
Broadbill	-	.09	-	-	.09	.15	0.1	.53	.60	.07	-	.21
Crow	-	-	.72	.48	.61	.70	0.6	.63	.73	.66	.19	.52
Fantail	-	-	-	-	.54	.89	0.55	.91	.96	.32	-	.47
Fruit Dove	-	.04	-	-	.07	.15	.85	.74	.72	.48	-	.32
Ground Dove	-	.04	.17	.82	.09	.23	0.2	.17	.16	.66	.05	.18
Honeyeater	-	.04	-	-	.13	.38	0.55	.49	.13	.18	-	.19
Kingfisher	-	.69	.56	.58	.33	.79	0.6	.73	.73	.98	.10	.62
P. T. Dove	.10	.87	0.5	.26	.59	.60	0.6	.26	.01	.30	.24	.37
Rail	-	.98	-	.14	.17	.02	-	0.2	-	.02	.05	.17
Starling	.14	.42	.11	.26	.89	1	0.9	.99	.97	.98	.14	.70
Whiteyes	-	-	-	-	.76	.02	-	.61	.54	-	-	.24
NO. OF COUNTS	21	45	18	73	46	47	20	70	67	44	21	472

Table 18. Species incidences of 11 forest birds of Guam recorded on weekly counts at 12 sites from October, 1978 to October, 1979. Names indicate cliffline points except Andersen South and Northwest Field.

	TOLANG	ANDERSEN SOUTH	LAJUNA	ANAO	PATI	TARAGUE	NORTH-WEST FIELD	RITIDIAN	URUNO	HAPUTO	TWO LOVERS POINT	TOTAL
Broadbill	-	1.0	-	-	1.0	1.0	1.0	1.24	1.3	1.0	-	1.22
Crow	-	-	2.23	3.69	1.96	2.12	1.92	1.66	1.59	2.14	2.0	1.81
Fantail	-	-	-	-	1.0	1.19	1.0	2.06	2.02	1.36	-	1.66
Fruit Dove	-	1.0	-	-	1.0	1.29	1.18	1.52	1.67	1.67	-	1.52
Ground Dove	-	1.0	1.0	1	1.0	1.18	1.25	1.17	1.27	2.34	1.0	1.57
Honeyeater	-	1.03	-	-	1.0	1.06	1.0	1.18	1.22	1.0	-	1.10
Kingfisher	-	1.23	1.10	1.17	1.33	1.22	1.5	1.75	1.43	1.91	1.0	1.45
P. T. Dove	1	2.13	1.0	1.37	1.52	1.39	1.0	1.28	1.0	1.23	1.2	1.49
Rail	-	3.02	-	1.5	1.63	1.0	-	1.21	-	1.0	1.0	2.29
Starling	1	1.74	1.50	1.84	2.66	2.81	1.17	3.80	2.98	3.58	1.0	2.88
Whiteyes	-	-	-	-	3.46	2.0	-	2.53	1.92	-	-	2.62
NO. OF COUNTS	21	45	18	73	46	47	20	70	67	44	21	472

Table 19. Relative abundance of 11 forest birds of Guam recorded on weekly counts at 12 sites from October, 1978 to October, 1979. Names indicate cliffline points except Andersen South and Northwest Field.

	TOLANG	ANDERSEN SOUTH	LAJUNA	ANAO	PATI	TARAGUE	NORTH-WEST FIELD	RITIDIAN	URUNO	HAPUTO	TWO LOVERS POINT	TOTAL
Broadbill	-	.03	-	-	.03	.05	.09	.18	.27	.02	-	.12
Crow	-	-	1.0	.98	.45	.53	1.0	.28	.40	.40	1.0	.47
Fantail	-	-	-	-	.21	.38	.48	.50	.66	.12	-	.39
Fruit Dove	-	.02	-	-	.02	.07	.87	.30	.41	.23	-	.24
Ground Dove	-	.02	.10	.12	.03	.10	.22	.05	.07	.44	.13	.14
Honeyeater	-	.02	-	-	.05	.14	.48	.15	.06	.05	-	.10
Kingfisher	-	.29	.38	1.0	.17	.34	.78	.34	.36	.53	.25	.45
P. T. Dove	.67	.62	.31	.53	.34	.30	.52	.09	.01	.10	.75	.27
Rail	-	1.0	-	.31	.11	.01	-	.06	-	.01	.13	.19
Starling	1.0	.25	.1	.71	.90	1.0	.91	1.0	1.0	1.0	.38	1.0
Whiteyes	-	-	-	-	1.0	.02	-	.42	.36	-	-	.32
NO. OF COUNTS	21	45	18	73	46	47	20	70	67	44	21	472

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Report prepared by: J. Mark Jenkins, Robert D. Anderson and Celestino F. Aguon

Guam broadbill nest and egg

Guam broadbill nest and chick

Appendix I

Proposals to place ten species of native bird on the Federal Endangered Species List.

Guam Rail, Rallus owstoni (Rothschild)
Order: Gruiformes
Family: Rallidae

Distinguishing Characteristics:

Head, neck and eye stripe brown with feathers on sides of neck tipped with rufous; superciliary stripe to back of neck; throat and upper breast near gray; mantle, back, scapulars, and some upper wing coverts dark olive-brown becoming browner on rump and upper tail coverts; wings dark with brownish spots and barred with white; lower breast, abdomen, under tail coverts and tail blackish with white barrings; bill gray; feet dark brown; tibia brown; iris red. Female similar but slightly smaller (Baker 1951).

Present Distribution:

Endemic to Guam of the Mariana Islands.

Former Distribution:

Same as above but formerly distributed over a larger area of Guam.

Status:

Threatened. Species has all but disappeared from southern Guam where it was formerly abundant. Major population now confined primarily to north-central Guam in mixed woodland and second growth habitats.

Estimated Numbers:

Five hundred to one thousand.

Breeding Rate in the Wild:

Nests primarily from July to November with a usual clutch size of four eggs, sometimes three (Perez, 1968). Most broods observed consist of three chicks, although broods of two and one have also been recorded. Number of clutches per year unknown.

Reasons for Decline:

The Guam Rail, having evolved a flightless habit in a predator free situation, is currently believed to suffer heavy losses from introduced predators. Guam currently has populations of feral dogs and cats, as well as rats, snakes and pigs. Of particular concern may be nest predation on the Guam Rail by the introduced Philippine rat snake (Boiga irregularis) and the monitor lizard (Varanus indicus). With a ground nesting habit, the rail may also suffer losses from three introduced species of rats (Roof rat, Rattus rattus; Norway rat, R. norvegicus; Polynesian rat, R. exulans). In December, 1975, a Philippine rat snake was collected and found to have a nearly full grown rail in its stomach. The Guam Rail suffers further mortality by the automobile, due to its habit of frequenting roadside habitats.

Protective Measures Already Taken:

Removed as game species in 1973 and currently protected by Guam law.

Measures Proposed:

Listing as threatened under the Endangered Species Act of 1973. Offer bounties on Philippine rat snakes and monitor lizards. Explore the possibility of a systematic trapping of introduced predators, especially in areas of high rail populations, in an effort to reduce the extent of predation.

Number in Captivity:

Several held at San Diego Zoo. Number held illegally by Guam residents unknown.

Breeding Potential in Captivity:

Unknown.

Remarks:

Lint (1968) noted that 15 species of Rail have become extinct in the past century, many of these in insular habitats. Roadside counts of the Guam Rail conducted by the Division of Aquatic and Wildlife Resources, Department of Agriculture, since 1965 yielded the following counts per 100 miles of travel:

'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75
46.9	53.0	30.4	42.2	66.2	37.7	38.0	14.7	9.7	5.4	8.0

On the roadside count covering southern Guam a high count of 18.0 rails per 100 miles of travel was recorded in 1967 and steadily declined to a low of 0.8/100 miles in 1976 when this count was discontinued.

References:

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Lint, K. C., 1968. A rail of Guam. Zoonooz 41(5):16-17.

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Marianas Gallinule, Gallinula chloropus guami Hartert
Order: Gruiformes
Family: Rallidae

Distinguishing Characteristics:

Adult: Head and neck sooty black; upper back slate-gray; lower back and wing-coverts brownish; wings dark brown, outer edge of first primary white; breast and upper abdomen slate-gray; under wing dark with white edges; under tail-coverts white; bill and frontal shield red, tip of bill yellowish; legs and feet olive-green. Adult female: Resembles male but with smaller frontal shield. Immature: Resembles adult but plumage more mottled with white and brown; frontal shield small (Baker 1951).

Present Distribution:

Guam (541 Km^2), Saipan (121.7 Km^2), Tinian (101.2 Km^2) and Pagan (48.4 Km^2) of the Mariana Islands. Restricted on Guam to Fena Lake, Agana Swamp, and a few small freshwater ponds. It has been recorded on Saipan at Lake Susupe, on Tinian at Lake Hagoi and Marpo Swamp, but not in large numbers (Drahos 1977).

Former Distribution:

Same islands as above. In 1945, Marshall (1949) described the populations as abundant in freshwater marshes on Saipan, Tinian and Guam. Strophlet (1946) recorded the species in a wetland area near Apra Harbor, Guam, but recent surveys of this reduced wetland area revealed no gallinule.

Status:

Endangered on Guam. Greatly reduced from former abundance on Guam and Tinian (Drahos 1977). Populations on Saipan and Pagan undetermined.

Estimated Numbers:

Less than 100 on Guam; less than 50 on Tinian (Drahos 1977); Saipan and Pagan undetermined.

Breeding Rate in the Wild:

Believed to nest primarily from January through July, although may breed year-round. Two complete broods have been observed on Guam; one of six chicks and one of eight.

Reasons for Decline:

Loss of suitable freshwater wetlands. Much wetland habitat has been drained on Guam and no wetlands are presently protected in the Marianas.

Protective Measures Already Taken:

Protected on Guam.

Measures Proposed:

Listing as endangered under Endangered Species Act of 1973. Declaration of Fena Lake, Agana Swamp and other wetlands on Guam as critical habitat. Collection of life history and ecological data. Virtually nothing is known of the life history or ecology of this species in the Marianas and acquisition of this information is essential if proper management proposals are to be initiated.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Good. The Hawaiian subspecies of this Gallinule (*Gallinula chloropus sandvicensis*) has been bred successfully in the Honolulu Zoo. No known attempts to breed *G. c. guami* are recorded.

Remarks:

Recent surveys of many of the freshwater areas on Guam have been conducted in an effort to determine the status of the Marianas Gallinule on Guam. Fena Lake on the U.S. Naval Magazine appears to be the major breeding area for the species on Guam. A survey of Fena Lake at low water during June, 1978, yielded a total of 23 gallinule in the following age classes: 10 adults; 5 immature; and 8 chicks (1 brood). A reliable report of the species still occurring in the Agana Swamp as of January, 1978, was received by the Division of Aquatic and Wildlife Resources (E. Kridler 1978, pers. comm.). In subsequent visits to the swamp only one gallinule was heard, although low water and thick vegetation makes observation difficult in this area. On a small privately owned pond in Yigo, Guam, four birds were observed with two chicks. These sightings represent the total number of birds recorded on Guam despite surveys of several other areas where this species was previously known to occur.

References:

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. Univ. of Kansas Mus. Nat. Hist. 3(1):1-359.

Drahos, N. 1977. Population dynamics of Guam Birds (unpublished). On file with Division of Aquatic and Wildlife Resources, Department of Agriculture, Guam.

Marshall, J. T. Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam and Palau. Condor 51:200-221.

Strophelet, E. H. 1946. Birds of Guam. Auk 63:534-540.

White-throated Ground Dove, _Gallicolumba xanthonura xanthonura_ (Temminck)
Order: Columbiformes
Family: Columbidae

Distinguishing Characteristics:

Adult male: Forehead, face, chin, throat, and upper breast white; crown, occiput, sides of head and nape rusty brown to dark brown; rest of upper parts dark bronze-olive; feathers of mantle broadly edged with metallic purple-violet; primaries, under wing coverts and axillaries brown; tail, lower breast and rest of underparts dark brown; bill and feet dark brown. Adult female: Smaller than male with underparts colored more cinnamon brown instead of dark brown and white; head and neck darker and with more rufous than underparts; remainder of upper surface resembles underparts but with striking olive-green sheen, especially on upper wing-coverts; tail rufous-brown with a broad, black subterminal band. Immature male: Resembles adult male, but head and nape darker brown; throat and upper breast may be more brown and less white. Immature female: Resembles adult female but with more rufous coloring; olive-green sheen on feathers reduced in amount or absent (Baker 1951).

Present Distribution:

Micronesia: Mariana Islands of Asuncion (7.3 km^2), Pagan (48.4 km^2), Almagen (11.1 km^2), Saipan (121.7 km^2), Tinian (101.2 km^2), Rota (85.5 km^2), and Guam (541 km^2); Yap (100 km^2) of the Caroline Islands. Guam distribution: Primarily confined to the northern cliffline of Guam with occasional sightings in north-central Guam. The species has not been recorded from the southern half of Guam for several years.

Former Distribution:

Same as above. Former Guam distribution: Occurring island-wide. Baker (1947) observed this species on 31.2% of 125 roadside counts made in 1945.

Status:

Endangered on Guam. Baker (1951) reports that the birds were numerous on Rota in 1945. In 1931, Coultas (in Baker 1951) observed only a few birds on Tinian and Downs (1946) similarly reported few birds on Tinian in 1945. No recent status surveys are available for this species or any native species in the Northern Marianas.

Estimated Numbers:

Fewer than 100 on Guam; other islands undetermined.

Breeding Rate in the Wild:

Virtually nothing is known of the breeding biology of this species, although Marshall (1949) lists _Gallicolumba xanathonura_ as one which breeds year-round.

Reasons for Decline:

Clearing of much of the native habitat on Guam due to increased urbanization. Many areas defoliated during World War II were subsequently reseeded with tangen-tangen (Leucaena leucocephala), rendering these areas virtually worthless to the native bird populations. The ground dove population on Guam and Rota was further deminished by Super typhoon Pamela of 1976. Some ground doves may be illegally or accidentally shot during the legal hunting season for the introduced Philippine Turtle Dove (Streptopelia bitorquata).

Protective Measures Already Taken:

Protected by Guam Territorial law.

Measures Proposed:

Declare critical habitat on Guam around the northern cliffline from NCS Beach to Mangilao on the east coast of Guam for a distance of 1.0 km from mean low water. Initiate a status survey of this species on the islands of the Northern Marianas and Yap. Explore the possibility of a captive propagation program since other columbiforms are known to breed successfully in captivity. Begin the collection of life history and ecological data on this species.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown, but other members of this family have bred successfully in captivity and the possibility of captive propagation for this species should be thoroughly explored.

Remarks:

Below is listed the mean number of ground doves observed per count on roadside censuses of 19.0 and 40.3 km in Northern Guam (AWR 1974-78).

	km	'74	'75	'76	'77	'78
Northwest Field	(19.0)	2.2	3.0	3.1	4.4	1.6
Northern Guam	(40.3)	1.2	1.7	1.9	1.2	1.3

Most of the biological fieldwork on the avifauna of Micronesia is over 30 year old, dating back in most cases to World War II. Current status surveys on the White-throated Ground Dove and all the native avifauna of Micronesia are long overdue.

References:

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Marianas Fruit Dove, Ptilinopus roseicapillus (Lesson)
Order: Columbiformes
Family: Columbidae

Distinguishing Characters:

A green dove with crown, forehead and a spot at the base of the mandible off-red; chin and throat pale yellow to white; lower breast with dark purple patch; abdomen orange with yellow green coloring at midline; anal regions and lower tail coverts yellow. Adult female: Resembles male, but slightly smaller with neck greener. Immature: Resembles adult, but lacking colored crown (Baker 1951).

Present Distribution:

Recorded from Guam (541 Km2), Rota (85.5 Km2), Tinian (101.2 Km2), and Saipan (121.7 Km2) of the Mariana Islands. Restricted on these islands to the remaining areas of natural vegetation. No longer found in the southern two-thirds of Guam, where as recently as 1967 fruit doves and their nests were still recorded.

Former Distribution:

Same as above but occurring in nearly all areas of the islands and in much greater numbers. In 1945 this dove was considered numerous to abundant on all islands (Marshall 1949, Baker 1951).

Status:

Endangered. Found on Guam only in the northern cliffline area from 0-500' elevation. Reduced range on Rota, Tinian and Saipan as well (Drahos 1977).

Estimated Numbers:

Guam 100: Total population on all four islands believed less than 500 individuals (Drahos 1977).

Breeding Rate in the Wild:

Clutch size usually one, sometimes two. Believed to breed primarily from October to July, although Marshall (1949) lists the species as one that breeds year-round. Number of clutches per year - unknown.

Reasons for Decline:

Loss of native habitat to urbanization with substantial clearing of forested areas taking place in the last 15 years mainly on Guam. Many areas defoliated during World War II were subsequently seeded with tangen-tangen (Leucaena leucocephala), rendering these areas virtually worthless to the native bird populations. The Marianas Fruit Dove was a huntable species on Guam until 1969 when it was given protection. Some fruit doves are still illegally or accidentally shot during the legal dove season for the introduced Philippine Turtle Dove (Streptopelia bitorquata). The Guam fruit dove population was further reduced by the recent Typhoon Pamela of 1976.

Protective Measures Already Taken:

Removed as game species in 1969 and given full protection under Guam territorial law. Most of the remaining habitat occurs on military land which excludes civilians but subjects the land to military uses. A foraging ecology and life history study of this species is currently being carried out part-time by a Government of Guam biologist.

Measures Proposed:

Listing of the species as endangered under the Federal Endangered Species Act of 1973. Declaration of critical habitat on Guam from Naval Communication Station beach around the northern cliffline area through the Anao Conservation Area to Mati Point from an elevation of 0' to 500' or for a distance of 0.5 Km from mean high water. Continue and expand the current ecology and life history studies until such time as an acceptable management plan can be developed.

Number In Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown.

References:

Aquatic & Wildlife Resources Division. 1965-1977. Job Progress Report. Federal Aid to Fish and Wildlife Restoration, Guam. Department of Agriculture.

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Strophlet, E. H. 1946. Birds of Guam. Auk 63:534-540.

Edible Nest Swiftlet, Collocalia inexpectata bartschi Mearns
Order: Apodiformes
Family: Apodidae

Distinguishing Characteristics:

Small, wing length 96 mm; upper parts dark green-brown; underparts brownish; feathers of chin, throat with sharply defined silvery-gray edges; abdomen dull gray; inconspicuous white spot on lores. Sexes alike (Baker 1951).

Present Distribution:

Guam (541 Km^2), Rota (85.5 Km^2), Tinian (101.2 Km^2), and Saipan (121.7 Km^2) of the Marianas Islands. Restricted on Guam to caves in the U.S. Naval Magazine area and along Route 17.

Former Distribution:

Same as above, but formerly much more abundant on Guam. Baker (1947) listed the swiftlet as the third most abundant species on roadside bird counts in the 1940's. As recently as 1966, the swiftlet population on Guam was estimated at 3,000 to 4,000 individuals.

Status:

Endangered on Guam. Currently the only area where the species is regularly sighted on Guam is on the U.S. Naval Magazine and along Cross-island Road (Route 17) adjacent to the Magazine. Populations on other islands unknown, but believed reduced.

Estimated Numbers:

One hundred to two hundred on Guam. Rota, Tinian, and Saipan unknown.

Breeding Rate in the Wild:

Believed to nest only once per year between January and July. Builds nests attached to cave walls. One egg per clutch (Drahos 1977).

Reasons for Decline:

Heavy use of insecticides (DDT, DDE) and herbicides during and following World War II. Body tissues of swiftlets were analyzed in 1975 for DDT and DDE concentrations and a mean concentration of 0.27 ppm (DDE) was found. Guano samples, similarly analyzed, showed DDE concentrations ranging from 0.01 to 0.10 ppm. The effect of such concentrations on the reproductive success of swiftlets remains unclear, however, other insectivorous species on Guam have shown a similar concurrent decline in population levels. An alternate or compounding reason for the decline of the swiftlet on Guam may be the recent introduction of the Black Drongo (Dicrurus macrocercus). This species was first recorded on Guam during the early 1960's and has flourished to a point where it now may be the most abundant avian species on Guam. It's similarity to the swiftlet in foraging technique, as well as it's population explosion occurring as the swiftlet population declined, suggests that some competition in foraging may have occurred between these two species.

Protective Measures Already Taken:

Protected on Guam.

Measures Proposed:

Listing as endangered under the Endangered Species Act of 1973. Protect caves at the U.S. Naval Magazine where this species is known to nest. Initiate a monitoring program to determine if the small remnant population of swiftlets is increasing or decreasing in numbers. Begin life history and ecological studies to determine the factors limiting population growth. Provided that sufficient populations exist elsewhere, examine the feasibility of reintroducing this subspecies in the northern cliffline area where the species was formerly abundant.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown.

Remarks:

On a survey of the U.S. Naval Magazine in June, 1978, 12-17 swiftlets were observed below the Fena Lake spillway. A month earlier only three swiftlets were observed in this same area, while two more swiftlets were sighted along Firebreak No. 4 on the Naval Magazine. The species continues to be irregularly sighted in small numbers along Cross-island Road (Route 17) adjacent to the Magazine.

One swiftlet was sighted at Janum Point in northern Guam on two separate occasions in June and July, 1978. In January and May, 1975, six and 25 swiftlets were sighted in this same area respectively. These sightings represent the only occurrence of swiftlets in the northern cliffline area of Guam; an area which once supported thousands of swiftlets (Strophelet, 1946).

References:

Baker, R. H. 1947. Size of bird populations on Guam, Marianas Islands. Condor 49(3):124-5.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. Univ. of Kansas Mus. Nat. Hist. 3(1):1-359.

Drahos, N. 1977. The status of the Edible Nest Swiftlet (*Collocalia inexpectata*) on Guam, M. I. (Unpublished). On file with Division of Aquatic and Wildlife Resources, Department of Agriculture, Guam.

Marshall, J. T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam, and Palau. Condor 51:200-221.

Strophelet, E. H. 1946. Birds of Guam. Auk 63:534-540.

Micronesian Kingfisher, Halcyon cinnamomina cinnamomina Swainson
Order: Coraciiformes
Family: Alcedinidae

Distinguishing Characteristics:

Head, neck, upper back and entire undersurface rusty brown; auriculars black with bluish wash; narrow black line extending around nape; orbital ring black; lower back, lesser wing-coverts and scapulars greenish-blue; outer webs of wing feathers and tail blue; rump resembles tail but slightly lighter; under wing-coverts greenish-blue; feet dark brown; bill black, base of mandible paler; iris dark brown. Adult female: Resembles adult male, but chin, throat and upper breast paler; rest of underparts and under wing-coverts white; a few cinnamon-tipped feathers on tibia and at bend of wing; back and scapulars darker olive-green and less blue. Immature: Resembles adult, but brown of crown mixed with greenish-blue; back and wing coverts edged with pale cinnamon; chin and throat whitish; rest of underparts buffy-white in male and paler in female; feathers on breast and nape with dark edgings (Baker 1951).

Present Distribution:

Subspecies endemic to Guam of the Mariana Islands. The subspecies is presently confined to the northern cliffline of Guam in remaining areas of the native limestone forest.

Former Distribution:

Same as above, but formerly occurring island-wide. Baker (1947) observed this species in 11.2% of 125 roadside counts, with the kingfisher representing 1.2% of all birds recorded. Seale (1901) found kingfishers to be "very common" near ranches and villages while Marshall (1949) described them as being abundant in woodlands. Baker (1951) reported the species to be "fairly common" on Guam preferring the marginal habitats between woodlands and openings. As recently as 1965, the kingfisher still was observed island-wide (Tubb 1966).

Status:

Endangered. Population has become extremely localized in the northern cliffline of Guam with a concurrent decrease in numbers.

Estimated Numbers:

100-150.

Breeding Rate in the Wild:

Clutch size probably three or more; number of clutches per year unknown. May concentrate nesting activities from January to July (Marshall 1949, and Baker 1951).

Reasons for Decline:

Loss of much of the native limestone forest of Guam. Most of the native bird populations were reduced by Super typhoon Pamela of 1976 and the kingfisher was no exception.

Protective Measures Already Taken:

Protected by Guam Territorial Law.

Measures Proposed:

Declare critical habitat for this species along the northern cliffline of Guam from NCS Beach to Mangilao for a distance of 1.0 km from mean low water. Initiate biological field studies and explore the possibility of captive propagation.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown.

Remarks:

Below is listed the mean number of kingfishers observed per count on roadside censuses of 19.0 and 40.3 km in Northern Guam (AWR 1974-78).

	km	'74	'75	'76	'77	'78
Northwest Field	(19.0)	0.9	1.3	1.4	1.9	1.3
Northern Guam	(40.3)	0.4	1.0	0.7	0.5	0.3

The northern cliffline of Guam, from NCS Beach to Mangilao, literally serves as the last refuge for many of the native birds of Guam, including the Micronesian Kingfisher. Although parts of the cliffline are in private ownership, much of it exists on military lands. While the military excludes private citizens from these areas, the land is always subject to military uses, often without consideration of the value of this land as wildlife habitat. In this sense, a declaration of critical habitat by the Fish and Wildlife Service would be extremely valuable in assuring that such consideration is not overlooked in the future. Purchase of lands in the northern cliffline under private ownership should be given top priority by both the federal and local governments. The continued existance of many of the native birds of Guam depends primarily on our ability to maintain, in a pristine condition, as much of the northern cliffline habitat as possible.

References:

AWR, 1974-78. Aquatic and Wildlife Resources Division, Department of Agriculture. Job Progress Reports, Federal Aid to Fish and Wildlife Restoration, Guam.

Baker, R. H. 1947. Size of bird populations at Guam, Mariana Islands. Condor 49:124-125.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution and distribution. Univ. of Kansas Pubs., Mus. Natur. Hist. 3(1):1-359.

Marshall, J. T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam and Palau. Condor 51:200-221.

Seale, A. 1901. Report of a mission to Guam. Occ. Papers Bernice P. Bishop Mus., 1:17-128.

Tubb, J. A. 1966. Notes on birds of Guam. Natur. Hist. Bull. Siam Soc. 21:135-138.

Micronesian Broadbill, Myiagra oceanica freycineti Oustalet
Order: Passeriformes
Family: Muscicapidae

Distinguishing Characteristics:

A small flycatcher with head and neck bluish with a metallic luster; lores and anterior forehead gray; back and upper wing coverts near green-blue; rump grayer than back; chin and throat white; breast light cinnamon, fading to pale buff and white on abdomen and under tail coverts; tail bluish-slate with tips of tail feathers edged with white; bill and feet black; iris dark brown. Adult female: More gray-brown above with less of a metallic luster; tibia less brownish. Immature: Resembles adult but more brown and less blue on back; underparts generally more buffy than adult (Marshall 1949, Baker 1951).

Present Distribution:

Subspecies endemic to Guam of the Mariana Islands. Presently confined to the remaining native limestone forest in the Northern cliffline of Guam.

Former Distribution:

Same as above, but formerly occurring over a greater area of Guam and in much greater numbers. Strophlet (1946) observed 4 broadbills on the Masso River in southern Guam and two along the southeast coast of Guam. No broadbills have been reported from the southern two-thirds of Guam in recent years.

Status:

Endangered. While this subspecies was probably never abundant, the loss of much of its native forest habitat has now made the Micronesian Broadbill one of the rarest birds on Guam. The species is presently confined to the northern cliffline habitat from NCS Beach around to Catalina Point on the east coast of Guam.

Estimated Numbers:

Fewer than 100.

Breeding Rate in the Wild:

Breeds year round. Believed to lay clutch of one or two eggs; number of clutches per year unknown (Drahos 1977).

Reasons for Decline:

Clearing of much of the native habitat due to increased urbanization. Prey availability in the remaining habitat may have been reduced by heavy use of insecticides during and after World War II. The population suffered further losses from the recent Super typhoon Pamela of 1976.

Protective Measures Already Taken:

Protected by Guam Territorial Law.

Measures Proposed:

Declare critical habitat around the northern cliffline from NCS Beach through Mangilao for a distance of 1.0 km from mean low water. Initiate field studies of the life history and ecology of the species until such time as a management plan can be developed.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown.

Remarks:

On roadside counts between 1974-1978, the Micronesian Broadbill has not been recorded despite censuses being conducted in former broadbill habitat (AWR 1974-78). The species has been observed recently in the mature limestone forest of the Northern cliffline, but is considered rare even in this habitat.

References:

AWR, 1974-78. Aquatic and Wildlife Resources Division, Department of Agriculture. Job Progress Reports, Federal Aid to Fish and Wildlife Restoration, Guam.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution and distribution. Univ. of Kansas Pubs., Mus. Natur. Hist. 3(1):1-359.

Drahos, N. 1977. Population dynamics of Guam birds (Unpublished). On file with Division of Aquatic and Wildlife Resources, Department of Agriculture, Guam.

Marshall, J. T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam and Palau. Condor 51:200-221.

Strophlet, J. J. 1946. Birds of Guam. Auk 63:534-540.

Bridled White-eye, Zosterops conspicillata conspicillata (Kittlitz)
Order: Passeriformes
Family: Zosteropidae

Distinguishing Characteristics:

Upper parts light green becoming slightly lighter on the rump; orbital ring broad and white; auriculars grayish-green; chin and throat yellowish-white; breast and abdomen dingy yellow; wing and tail feathers dark brown with greenish-yellow edges; upper mandible yellow and darker than lower mandible; legs and feet dark olive-gray; iris light umber. Adult female: Lighter on underparts. Immature: Underparts paler yellow and upper mandible light yellowish-brown (Marshall 1949, Baker 1951).

Present Distribution:

Subspecies endemic to Guam of the Mariana Islands. Presently confined to the northern cliffline in the remaining native limestone forest.

Former Distribution:

Formerly occurring island-wide. Seale (1901) reported the species to be common on Guam with flocks ranging in size from ten to twenty individuals. Strophelet (1946) found the species in grasslands of foothills and occurring in flocks of 2-3. Arvey, in Baker (1951), recorded a flock of 12 white-eyes at Mt. Tenjo in July, 1946. Arvey's sighting represents the last record of white-eyes in the southern half of Guam.

Status:

Endangered. The species is presently confined to the limestone forest occurring in the northern cliffline of Guam.

Estimated Numbers:

Less than 150.

Breeding Rate in the Wild:

Marshall (1949) lists Zosterops conspicillata as a species which breeds year-round. Clutches consist of 2 or 3 eggs (Baker 1951); number of clutches per year unknown.

Reasons for Decline:

Loss of much of the native habitat on Guam due to increased urbanization. The Bridled White-eye is presumed to be primarily insectivorous, and may have been affected by heavy use of insecticides during and following World War II. The population is believed to have suffered heavy losses during Super typhoon Pamela of 1976.

Protective Measures Already Taken:

Protected by Guam Territorial Law.

Measures Proposed:

Declare critical habitat around the northern cliffline of Guam from NCS Beach through Mangilao for a distance of 1.0 km from mean low water. Begin the collection of life history and ecological data on this species until such time as a management plan can be developed.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown.

Remarks:

Below is listed the mean number of white-eyes observed per count on roadside censuses of 19.0 and 40.3 km in Northern Guam (AWR 1974-78).

	km	'74	'75	'76	'77	'78
Northwest Field	(19.0)	0	0	0.1	0	0
Northern Guam	(40.3)	0	0	0.1	0	0

In over 100 hours of field observations in the northern cliffline area during 1978, fewer than twenty white-eyes have been recorded; it is likely that some of these birds were the same individuals recorded more than once.

References:

AWR, 1974-78. Aquatic and Wildlife Resources Division, Department of Agriculture. Job Progress Reports, Federal Aid to Fish and Wildlife Restoration, Guam.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution and distribution. Univ. of Kansas Pubs., Mus. Natur. Hist. 3(1):1-359.

Marshall, J. T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam and Palau. Condor 51:200-221.

Seale, A. 1901. Report of a mission to Guam. Acc. Papers Bernice P. Bishop Mus., 1:17-128.

Strophlet, J. J. 1946. Birds of Guam. Auk 53:534-540.

Cardinal Honey-eater, Myzomela cardinalis saffordi Wetmore
Order: Passeriformes
Family: Meliphagidae

Distinguishing Characteristics:

Head, neck, back, rump, upper tail-coverts, chin, throat, breast and upper abdomen scarlet; rest of plumage dark brown; bill long, curved and black; feet black; iris dark brown. Adult female: Resembles adult male, but smaller; red coloration duller; wings and tail more brownish; abdomen and under tail-coverts dark gray. Immature: Resembles adult, but red coloration reduced; underparts pale buffy-brown (Baker 1951).

Present Distribution:

Recorded from Guam (541 km^2), Rota (85.5 km^2), Tinian (101.2 km^2), Agiguan (7.3 km^2), Saipan (121.7 km^2), Almagan (11.1 km^2), Pagan (48.4 km^2), Agrihan (47.4 km^2) and Asuncion (7.3 km^2) of the Mariana Islands.

Former Distribution:

Same as above. Formerly distributed island-wide on Guam, this species was the fourth most abundant bird recorded by Baker (1947), with the Cardinal Honey-eater observed on 37.6% of 125 roadside counts and representing 3.9% of all birds seen.

Status:

Endangered on Guam and probably several other islands as well. On Guam the species is presently confined in small numbers, to the northern cliffline of Guam from NCS Beach through the Anao Conservation area and the Northwest Field area of Andersen Air Force Base. As recently as 1965, Tubb (1966) reports the species was still distributed island-wide on Guam. In almost five months of observation Downs (1945) sighted only two honey-eaters on Tinian. Borror (1947) reported the species to be common at Agrihan in 1945. It is unfortunate that no recent status surveys of the native birds of the Northern Marianas are available.

Estimated Numbers:

100-200 on Guam; other islands unknown.

Breeding Rate in the Wild:

Probably nests year-round (Marshall 1949). Clutch size consists of two eggs (Baker 1951); number of clutches per year unknown.

Reasons for Decline:

On Guam, the loss of most of the native limestone forest has restricted the species to the remaining areas of pristine limestone forest occurring in the northern cliffline. The species has virtually disappeared from the southern two-thirds of Guam, possibly due to the heavy spraying of insecticides in these areas during and after World War II. The population on Guam suffered further declines from Super typhoon Pamela of 1976. Population status on other islands is undetermined.

Protective Measures Already Taken:

Protected by Guam Territorial Law.

Measures Proposed:

Declare critical habitat on Guam along the northern cliffline from NCS Beach to Mangilao for a distance of 1 km. from mean low water; designate the Northwest Field area of Andersen Air Force Base as critical habitat as well. Initiate status surveys of this species in the Northern Marianas, with the goal of reintroducing the species to suitable areas on Guam, if sufficiently large populations exist elsewhere. Begin the collection of biological data on the species as time and manpower permit.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown.

Remarks:

Below is listed the mean number of Cardinal Honeywaters observed per count on roadside censuses of 19.0 and 40.3 km. in Northern Guam (AWR 1974-78).

	km	'74	'75	'76	'77	'78
Northwest Field	(19.0)	1.8	5.6	6.1	5.8	6.0
Northern Guam	(40.3)	3.2	4.1	1.8	0.7	0.3

While the status of this species remains undetermined for most of the Northern Marianas, there is little doubt that the Guam population is in danger of extirpation. Since Guam represents over 50% of the species former range, a listing of endangered on the U.S. Endangered Species List appears appropriate.

References:

AWR, 1974-78. Aquatic and Wildlife Resources Division, Department of Agriculture. Job Progress Reports, Federal Aid to Fish and Wildlife Restoration, Guam.

Baker, R. H. 1947. Size of bird populations at Guam, Mariana Islands. Condor 49:124-125.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. Univ. of Kansas Pubs., Mus. Natur. Hist. 3(1):1-359.

Barror, D. J. 1947. Birds of Agrihan. Auk 64:415-417.

Downs, T. 1946. Birds on Tinian in the Marianas. Trans. Kansas Acad. of Sci. 49(1):87-106.

Marshall, J. T. 1949. The endemic avifauna of Saipan, Tinian, Guam and Palau. Condor 51:200-221.

Tubb, J. A. 1966. Notes on the birds of Guam. Natur. Hist. Bull. Siam Soc. 21:135-138.

Marianas Crow, Corvus kubaryi Reichenow
Order: Passeriformes
Family: Corvidae

Distinguishing Characteristics:

Adult: A small, black crow with a slight greenish-black gloss on head; back, wings and tail with bluish-black gloss; underparts with dull, greenish-black gloss; bases of feathers light grayish, more nearly white on neck, producing a somewhat ragged appearance; nasal bristles short but extending over nostrils and base of culmen; bill and feet black; iris dark brown. Female smaller. Immature: Resembles adult, but feathers with less gloss; wings and tail browner (Baker, 1951).

Present Distribution:

Species endemic to Guam (541 km^2) and Rota (85.5 km^2) of the Mariana Islands. On Guam the species is presently confined to the northern cliffline area from NCS Beach to Mangilao, and the Northwest Field area of Anderson Air Force Base. Local distribution on Rota unknown.

Former Distribution:

Same as above, but formerly distributed island-wide on Guam. Baker (1947) recorded this species on 21.6% of 125 roadside counts on Guam, with the crow representing 2.4% of the total number of birds observed. Seale (1901) reported this species to be common in jungles of Guam and noted their noisy behavior. Kibler (1950) observed the Marianas Crow at Tumon; an area where this species has not been recorded in recent years. The last sightings of the Marianas Crow in the Southern half of Guam occurred in the mid-1960's, but in very low numbers. There have been no recent sightings of the crow in Southern Guam despite extensive fieldwork in this area. The population on Rota is believed to be reduced from former abundance, although no recent fieldwork for this island is available.

Status:

Endangered.

Estimated Number:

100-150.

Breeding Rate in the Wild:

Believed to breed primarily in winter and spring. Clutches of three or more eggs are most common. Number of clutches per year unknown.

Reasons for Decline:

Loss of much of the native forest habitat on Guam due to increased urbanization. Hunters and poachers on Guam are reputed to shoot crows on sight, as they believe the crows' noisy behavior frightens game. On Rota the crow is considered a pest and is often shot by farmers.

Protective Measures Already Taken:

Protected by Guam Territorial Law.

Measures Proposed:

Declare critical habitat on Guam along the northern cliffline from NCS Beach to Mangilao for a distance of 1.0 kilometer from mean low water. Initiate biological studies of the life history and ecology of this species with the goal of identifying areas useful for nesting, roosting and feeding. The generalized omnivorous feeding habits of the Marianas Crow suggest the possibility of captive propagation.

Number in Captivity:

Unknown.

Breeding Potential in Captivity:

Unknown, but should be explored.

Remarks:

Below is listed the mean number of crows observed per count on roadside censuses of 19.0 and 40.3 km in Northern Guam (AWR 1974-78).

	km	'74	'75	'76	'77	'78
Northwest Field	(19.0)	2.4	3.6	3.3	4.3	0.2
Northern Guam	(40.3)	0.3	0.2	0.6	0.4	0.1

The Marianas Crow is the only native crow found in Micronesia, and represents the only native member of the family Corvidae in the U.S. Trust Territory. It is possible that this species is a remnant of a population which formerly had a more extensive distribution.

References:

AWR, 1974-78. Aquatic and Wildlife Resources Division, Department of Agriculture. Job Progress Reports, Federal Aid to Fish and Wildlife Restoration, Guam.

Baker, R. H. 1947. Size of bird populations at Guam, Mariana Islands. Condor 49:124-125.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution and distribution. Univ. of Kansas Pubs., Mus. Natur. Hist. 3(1):1-359.

Kibler, L. F. 1950. Notes on the birds of Guam. Auk 67:400-403.

Seale, A. 1901. Report of a mission to Guam. Occ. Papers Bernice P. Bishop Mus., 1:17-128.

Appendix II

CHECK LIST OF THE BIRDS OF GUAM

Revised October, 1979, by J. Mark Jenkins
Division of Aquatic & Wildlife Resources
Department of Agriculture
P.O. Box 23367 GMF
Guam, Mariana Islands 96921

Legend:
N = Native resident
I = Introduced resident
M = Migratory

C = Common
U = Uncommon
R = Rare
A = Accidental
E = Extirpated

Dates indicate when first reported from Guam

FAMILY AND SCIENTIFIC NAMES	COMMON NAME	STATUS
PROCELLARIIDAE - Petrels and Shearwaters		
Puffinus pacificus chlororhynchus - 1931	Wedge-tailed Shearwater	A
Puffinus tenuirostris - 1971	Short-tailed Shearwater	A
Puffinus lherminieri - 1901	Audubon Shearwater	A
Puffinus puffinus newelli - 1974	Manx Shearwater	A
HYDROBATIDAE - Storm Petrels		
Oceanodroma matsudairae - 1962	Matsudaira Storm Petrel	A
PHAETHONTIDAE - Tropicbirds		
Phaethon lepturus - 1926	White-tailed Tropicbird	N,U
SULIDAE - Boobies and Gannets		
Sula sula - 1905	Red-footed Booby	A
Sula leucogaster - 1901	Brown Booby	N,R
Sula dactylatra - 1979	Masked Booby	A
FREGATIDAE -Frigatebirds		
Fregata minor - 1899	Greater Frigatebird	A
ARDEIDAE - Egrets, Herons, and Bitterns		
Bubulcus ibis - 1971	Cattle Egret	M,C

CHECK LIST OF THE BIRDS OF GUAM

FAMILY AND SCIENTIFIC NAMES	COMMON NAME	STATUS
gretta intermedia - 1946	Plumed Egret	M,C
gretta sacra - 1836	Reef Egret	N,C
xobrychus sinensis - 1824	Chinese Least Bittern	N,C
upetor flavicollis - 1901	Black Bittern	A
utorides striatus - 1979	Little Heron	A
TIDAE - Ducks, Geese, and Swans		
nas oustaleti - 1887	Marianas Mallard	N,E
nas querquedula - 1964	Garganey Teal	M,R
nas acuta - 1945	Pintail	M,R
nas clypeata - 1973	Shoveler	M,R
ythya fuligula - 1904	Tufted Duck	M,R
IPITRIDAE - Hawks and Allies		
ccipiter gularis - 1887	Asiatic Sparrow Hawk	A
DIONIDAE - Osprey		
andion haliaetus melvillenisis - 1945	Osprey	A
CONIDAE - Falcons		
alco peregrinus - 1945	Peregrine Falcon	A
alco subbuteo - 1979	Northern Hobby	A
APODIIDAE - Megapodes		
egapodius l. laperouse	Micronesian Megapode	N,E
SIANIDAE - Quails, Pheasants, and Allies		
rancolinus francolinus - 1961	Black Francolin	I,C
oturnix chinensis lineata - 1894	Chinese Painted Quail	I,U
LIDAE - Rails, Gallinules, and Coots		
allus owstoni - 1867	Guam Rail	N,R
oliolimnas cinereus micronesiae - 1898	White-browed Rail	N,E

CHECK LIST OF THE BIRDS OF GUAM

FAMILY AND SCIENTIFIC NAMES	COMMON NAME	STATUS
Gallinula chloropus guami - 1824	Guam Gallinule	N,R
Fulica atra - 1901	Common Coot	A
CHARADRIIDAE - Plovers		
Pluvialis squatarola - 1888	Black-bellied Plover	M,R
Pluvialis dominica fulva - 1836	American Golden Plover	M,C
Charadrius dubius - 1967	Little Ringed Plover	M,R
Charadrius mongolus - 1896	Mongolian Dotterel	M,C
Charadrius leschenaultii - 1962	Great Sand Plover	M,R
Charadrius hiaticula - 1979	Common Ringed Plover	M,R
SCOLOPACIDAE - Sandpipers and Allies		
Limosa limosa - 1978	Black-tailed Godwit	M,R
Limosa lapponica - 1898	Bar-tailed Godwit	M,U
Numenius phaeopus - 1836	Whimbrel	M,C
Numenius tahitiensis - 1962	Bristle-thighed Curlew	M,R
Numenius madagascariensis - 1898	Long-billed Curlew	M,R
Tringa nebularia - 1962	Common Greenshank	M,R
Tringa glareola - 1896	Wood Sandpiper	M,R
Tringa erythropus - 1978	Spotted Redshank	M,R
Actitus hypoleucos - 1888	Common Sandpiper	M,U
Heteroscelus brevipes - 1836	Gray-tailed Tattler	M,C
Heteroscelus incanus - 1888	Wandering Tattler	M,C
Arenaria interpres - 1824	Ruddy Turnstone	M,C
Gallinago megala - 1898	Marsh Snipe	M,R
Calidris alba - 1898	Sanderling	M,U
Calidris acuminata - 1901	Sharp-tailed Sandpiper	M,U
Calidris subminuta - 1962	Long-toed Stint	M,U
Calidris ruficollis - 1979	Rufous-necked Stint	M,R
LARIDAE - Gulls and Terns		
Larus ridibundus - 1978	Black-headed Gull	A
Chlidonias leucopterus - 1896	White-winged Black Tern	A
Sterna hirundo - 1962	Common Tern	A
Sterna sumatrana - 1973	Black-naped Tern	A
Sterna fuscata - 1971	Sooty Tern	A
Anous stolidus - 1887	Noddy Tern	N,C
Gygis alba candida - 1898	White Tern	N,C

CHECK LIST OF THE BIRDS OF GUAM

FAMILY AND SCIENTIFIC NAMES	COMMON NAME	STATUS
AREOLIDAE - Pratincoles		
Glareola lactea - 1979	Small Pratincole	A
LUMBIDAE - Pigeons and Doves		
Columba livia	Rock Pigeon	I,C
Streptopelia bitorquata - 1770	Philippine Turtle Dove	I,C
Gallicolumba x. xanthonura - 1833	White-throated Ground Dove	N,R
Ptilinopus roseicapillus - 1833	Marianas Fruit Dove	N,R
RIGIDAE - Owls		
Asio flammeus - 1969	Short-eared Owl	A
ODIDAE - Swifts		
Collocalia vanikorensis bartschi - 1836	Vanikoro Swiftlet	N,R
CEDINIDAE - Kingfishers		
Halcyon c. cinnamomina - 1821	Micronesian Kingfisher	N,R
RUNDINIDAE - Swallows		
Hirundo rustica gutturalis - 1945	Barn Swallow	A
LVIIDAE - Old World Warblers		
Acrocephalus l. luscinia - 1830	Nightingale Reed-warbler	N,E
CICAPIDAE - Old World Flycatchers		
Myiagra freycineti - 1881	Micronesian Broadbill	N,R
Rhipidura rufifrons uraniae - 1859	Rufous-fronted Fantail	N,R
TEROPIDAE - White-eyes		
osterops c. conspicillata - 1833	Bridled White-eye	N,R

CHECK LIST OF THE BIRDS OF GUAM

FAMILY AND SCIENTIFIC NAMES	COMMON NAME	STATUS
MELIPHAGIDAE - Honeyeaters		
Myzomela cardinalis saffordi - 1832	Cardinal Honeyeater	N,R
ESTRILDIDAE - Waxbills and Allies		
Lonchura malacca jagori - 1957	Chestnut Mannikin	I,C
PLOCEIDAE - Sparrows and Weavers		
Passer montanus saturatus - 1956	Eurasian Tree Sparrow	I,C
STURNIDAE - Starlings		
Aplonis opacus guami - 1883	Micronesian Starling	N,U
DICRURIDAE - Drongos		
Dicrurus macrocercus - 1956	Black Drongo	I,C
CORVIDAE - Crows and Jays		
Corvus kubaryi - 1836	Marianas Crow	N,R

Section VI

Guam Wildlife Investigations
(Miscellaneous Funds)

Project Title:	The Current Status and Distribution of the Marianas Fruit Bat on Guam.
Period Covered:	June - September 1978
Funding Sources:	The Coastal Zone Management Program and Federal Aid to Fish and Wildlife on Guam.

This report was completed in September, 1978, and published as Technical Report No. 1 of the Division of Aquatic and Wildlife Resources. The authors were Michael E. Wheeler and Celestino F. Aguon.

ABSTRACT

An intensive, island-wide survey was conducted to determine the status of the Marianas fruit bat (Pteropus mariannus) on Guam. All areas where fruit bats had been formerly sighted by Division biologists were repeatedly surveyed throughout the summer. Fruit bats were sighted only in the coastal limestone forest running below and parallel to the cliffline from the Naval Communications Station to the Pati Point Natural Area on Andersen Air Force Base, and in the swamp or ravine forests of the U.S. Naval Magazine in south-central Guam.

The maximum fruit bat population in the areas surveyed was estimated to be 50 bats, and the distribution was much more restricted than previous sightings indicated. Fruit bats were observed to be active during the day, but most of this diurnal activity was concentrated in the early morning hours. The most preferred roosting trees were cliffside ironwood trees (Casuarina equisetifolia) and large banyan or fig trees (Ficus prolixa). The majority of observations of fruit bats were of single bats and the largest group of bats sighted consisted of 15 individuals. The hunting history of the Marianas fruit bat was deemed to be the most significant factor relative to the decline of this species. Another factor contributing to the decline has been the loss of considerable amounts of mature forest habitat on which fruit bats depend. Recommendations were made for critical habitat designation and for performance guidelines to be used in land-use planning.

Section VII

Technical Guidance
(Federal Aid in Fish and Wildlife Restoration Acts)

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

TERRITORY: Guam

PROJECT NO.: FW-2R-16

JOB NO.: TG-1

PROJECT TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources

PERIOD COVERED: July 1, 1978 to September 30, 1979

BACKGROUND:

The rapid development of Guam's economy has resulted in increasing demands upon Guam's natural resources. The trend toward urbanization has brought an increase in the construction of recreational, commercial, military, and public utility facilities, all of which have some impact upon the environment. To help minimize long-term adverse impacts of such developments, the Division of Aquatic and Wildlife Resources has taken an increasingly active role in the area of technical guidance. These responsibilities are increasing rapidly because review is now legally required for many development plans, permit applications, and impact statements.

OBJECTIVES:

I. To minimize adverse impact resulting from the construction of recreational, commercial, military and public utility facilities.

II. To minimize the impacts of accidental spills of oil and other toxic substances.

III. To ensure that development and utilization of Guam's coastal and interior areas does not result in deterioration of the environment.

PROCEDURES:

I. Review and comment on Environmental Assessment Reports, Environmental Impact Statements, permit applications and development plans pertaining to developments on Guam.

II. Conduct the field investigations necessary to adequately conduct these reviews.

III. Provide technical assistance to military and civil agencies relative to the management of fish and wildlife resources.

IV. Participate in the Regional Response Team for petroleum and toxic substance spills.

FINDINGS:

The staff of the Division has been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations have been conducted in many cases as a part of the review process.

Various Divisional staff members actively serve as members of the following groups:

1. Western Pacific Regional Fisheries Management Council.
2. Guam Marine Fisheries Advisory Council
3. Regional Response Team
4. Animal Impact Screening Committee
5. Territorial Seashore Park Management Committee
6. Subdivision and Development Review Committee
7. Renewable Resources Extension Program
8. Agana Bay Urban Waterfront Task Force
9. Agana Marina Task Force
10. Ad-hoc Zoo Committee

Members of the Division have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Divisional staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Navy, and the U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who were received during the segment.

Considerable public contact was maintained by Divisional staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspapers, staff members conducted tours of Department of Agriculture facilities in conjunction with a Farmers Union Fair, and gave talks to the following groups:

1. University of Guam Environmental Biology Class
2. New Piti Elementary School
3. P.C. Lujan Elementary School
4. Tweeds Cave Rod and Gun Club
5. Taotaomona Rod and Gun Club
6. Southern Marianas Sportsmans Club
7. Navy Air Photo Laboratory

Some of the major issues addressed during this segment are:

1. Ugum River Dam. The Environmental Impact Statement on the proposed Ugum River Dam was reviewed and comments submitted to the U.S. Army Corps of Engineers. Several field investigations into the Ugum and Inarajan River basins were conducted prior to this review.

2. Micronesian Cultural Center. A proposal to lease government land in Agana Swamp to a group planning to construct a Micronesian Cultural Center was reviewed. Oral and written comments were delivered to the 15th Guam Legislature, who were considering the lease application.

3. Orote Point Ammunition Wharf. The proposal by the U.S. Navy to construct an ammunition wharf facility at Orote Point was reviewed and several field inspections conducted. Written and oral comments were delivered at the public hearings held jointly by the Navy and the Army Corps of Engineers.

4. Tarague Beach Rifle Range. The proposal by the Air Force to make major modifications to the small-arms range near Tarague Beach was reviewed. Comments and recommendations made to the Air Force resulted in major modifications to the proposal and the completion of a scaled-down project.

5. Waste Water Facilities Plan. Staff met with representatives of U.S./EPA, GEPA, PUAG, Public Works, and the wastewater project consultant on several occasions to discuss the probable impacts of the wastewater facilities on wildlife resources. Field inspections of proposed sites were made and written comments submitted to the concerned agencies.

6. Army Corps of Engineers Notices of Violation. Field inspections were performed and comments prepared regarding cases of illegal fill or other activities in Agfayan Bay, Agat, Masso River, the Atantano River, and other areas on Guam.

7. Several public hearings and meetings were attended regarding numerous development proposals including a harbor of refuge in Apra Harbor, Cocos Island development, the Agana boat basin and Agat small boat harbor, island-wide maintenance dredging of streams and rivers, and several subdivision and redevelopment plans. In most cases written comments were submitted to the concerned agencies.

8. Meetings were attended regarding the management of the newly established Territorial Seashore Park, development of a Fisheries Management Plan for Guam, the establishment of a 100-mile fishery conservation zone, the re-definition of the Seashore Reserve Boundary, and the use of ponding basins as wildlife refuges.

9. Meetings and hearings regarding the passage of the Guam Endangered Species Act were attended. Written and oral testimony was delivered to the 15th Guam Legislature regarding this important bill, and recommendations were made to bring the bill into compliance with the Federal Act. The bill was passed and signed into law. The Division now qualifies for funding under Section 6 of the federal Endangered Species Act of 1973 and has drafted a Cooperative Agreement for approval by the U.S. Fish and Wildlife Service.

10. Several meetings were held with military authorities. Staff met with Andersen Air Force Base representatives to review our Sikes Act agreement with the Air Force and to advise their Bird Strike Task Force. Naval personnel at the Naval Magazine and Ship Repair Facility were briefed on the meaning of critical habitat designations.

11. Staff attended numerous meetings and conducted several field investigations in regard to the removal of the M. V. Peace Ocean from a reef in Apra Harbor. The vessel was intended to be towed to Facpi Point and sunk as an artificial reef, but it developed severe leaks during removal and had to be sunk in deep water several miles offshore.

12. Several field investigations were conducted in regard to reported accidental fish kills, illegal coral harvesting, the use of chemicals and explosives to harvest fish, herbicide spraying at Andersen Air Force Base, and the use of rodenticides at the Federal Aviation Authority facility.

Section VIII

Law Enforcement
(Local Funds)

ENFORCEMENT SECTION
ANNUAL REPORT

Beginning June 1, 1978 to September 30, 1979, fourteen (14) separate arrests for illegal hunting were made by the Conservation Officers. All apprehensions were made at night during late evening and early morning hours. Of these arrests, a total number of 36 adults and one minor were involved. The suspects in these cases either pleaded guilty or were deferred by the Attorney General.

Incidents which didn't materialized into cases were also recorded. They are as follows: Seven incidents of illegal capturing of wild game; twenty seven illegal spotlighting as an aid to take game; seven fish poisoning; five dynamiting; and one illegally constructed fish weir.

A joint civil/military operation was conducted in Naval Magazine to prevent illegal hunting and unauthorized personnel from trespassing. One daylight sweep was conducted in the area by Marine personnel and the Conservation Officers. Four night patrols were set up by the Conservation Officers with the Marine securities, Navy securities and the SED of the Department of Public Safety participating in the operations.

All four Conservation Officers attended the Consolidated Law Enforcement Training Program and completed 90 hours of courses including self-defense and qualifying with a .38 Cal. revolver.

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